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XVIII
PALEONTOLOGY OF COYOTE MOUNTAIN,
IMPERIAL COUNTY, CALIFORNIA

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INTRODUCTION

When I assumed the duties of Curator of the Department of Paleontology in 1919, I found in the Department two large collections of fossil mollusks from Coyote Mountain, Imperial County, California. These had been borrowed for study and report by former Curator, Roy E. Dickerson, and he had done a very considerable amount of work in the identification of the species. Up to the time of his departure, he was unable to complete the work to his satisfaction, and in 1920, he turned the matter over to me either to finish or return the collections to their owners. After due consideration, the advice of Dr. J. P. Smith and Dr. B. L. Clark was taken and the work of identification was completed as nearly as possible and the collections were returned.

Publication has been withheld until this time because it was found that the fauna needed for critical comparison was to be had only in the Gulf of California. Until the Academy sent its expedition there in 1921, no collection of consequence was available in any western museum for consultation. That year, through the untiring industry of Dr. Fred Baker, a very large number of the known species of that province was brought back. Also through his efforts the larger forms have been identified and it has been possible to compare the Coyote Mountain fossils with them.

This procedure has prevented a very considerable number of inaccuracies which would have been inevitable had the report been published in 1921. The most fertile source of error would have been due to making comparison of this relatively poorly preserved material with living and fossil species from east American and West Indian points. Unquestionably, the Coyote Mountain fauna is closely related to that of the Atlantic, but so is the fauna of the Gulf of California. In no great number of cases does this similarity amount to exact identity of species. Without a good Gulf of California collection for comparison, grave errors would have been unavoidable.

The tropical fauna of the Gulf of California is so vastly different from any known from the California coast that with only the latter and eastern collections available, the natural

conclusion students would reach would be to associate the Coyote Mountain forms with those of the Atlantic of similar tropical facies.

Even with the Gulf of California collection for comparison, this report could hardly have been completed without the hearty cooperation of many paleontologists. Particularly must appreciation be acknowledged to Dr. Fred Baker; Dr. J. P. Smith; Dr. B. L. Clark; Dr. Roy E. Dickerson; Mrs. Kate Stephens; Mr. Chas. H. Sternberg; Dr. W. H. Dall; and Mr. W. C. Mansfield.

LOCATION

Coyote Mountain, sometimes called Carrizo Mountain, is located in the western part of the Colorado Desert, Imperial County, California. It is close to the great granite range which extends from Mount San Jacinto on the north to Mount San Pedro Martir in Lower California.

The base of the mountain is about three miles north of Coyote Wells, a watering station on the highway from San Diego to El Centro and Yuma. The United States-Mexican boundary is about four miles south of Coyote Wells.

The crest of the mountain is a ridge about five miles long extending almost east and west. The surrounding country is excessively barren desert and most of the usual erosion-features common to such surroundings are found. Thus there are broad gravel washes, steep box cañons and many perpendicular escarpments.

North of Coyote Mountain about ten miles there is another and larger mountain mass, likewise an intrusion through Tertiary sediments, now known as Fish Creek Mountain. Between it and Coyote Mountain is the flood plain of Carrizo Creek. This is a very ancient waterway; in the granitic mountains which it traverses it has cut a great gorge, celebrated for its scenic features.

Coyote Mountain is now easily reached since it is only three miles from a paved highway. Light automobiles are usually driven almost any place on the desert floor and by following the wider washes it is possible to drive into several of the main cañons. Alverson Cañon can thus be reached.

PREVIOUS WORK

The original discovery of the Coyote Mountain uplift was made by W. P. Blake, geologist with the Pacific Railroad Survey. The party with which he traveled camped on Carrizo Creek where this stream flows out of its cañon and is lost in the sands of the Colorado Desert. Here some fossils were found and collected.¹ These were subsequently described by Conrad² as *Ostrea heermanni*, *Anomia subcostata* and *Pecten deserti*, all new species and *Ostrea vespertina*, previously described from San Diego.³ With only these four species, Conrad thought the age of the deposit from which they came was probably Miocene.

I do not find any other publication based upon original investigations until the report of Charles R. Orcutt was issued in 1890. (See bibliography for references.) He traveled extensively in the Colorado Desert at an early date, and, it appears, made large collections of fossils from the marine sediments in the Coyote Mountain district. He mentioned particularly corals and oysters. Much of his data was reprinted in 1901.

H. W. Fairbanks next collected in the region about 1892 and some of the corals he secured were sent to Dr. T. W. Vaughan who described them in 1900. There were two species and one subspecies of these.

Dr. Stephen Bowers made another collection of corals in 1901 and published a short paper on his observations. This collection was likewise studied by Dr. Vaughan, who published some notes on it in *Science* in 1904.

This latter collection was so interesting that Dr. Vaughan arranged to have Dr. Bowers and Mr. W. C. Mendenhall visit the locality and a very much more extensive collection was made. A brief list of some of the Mollusca contained in the collection was published in 1906 by Dr. Ralph Arnold. He also included a preliminary list of the corals and described two new species of *Pecten* from the locality. As a result of

¹ See Blake, Pac. R. R. Repts., Vol. 5, 1857, pp. 120-123.

² Op. cit., pp. 325-326, pl. 5. The original descriptions (without illustrations) appeared in an octavo appendix to the preliminary report of the geologist of the survey, published in 1855 as House Executive document 129, 33rd Cong. 1st Sess.; citations are usually made to the final quarto report in Vol. 5.

³ It so happens that descriptions of the two first mentioned appeared in February, 1855, without illustrations in Proceedings of the Academy of Natural Science of Philadelphia, p. 257.

Mr. Mendenhall's visit, he published in 1910 the most extensive account we have of the geology of the district.

One of the sea urchins collected in 1904 was appropriately described the same year by Charles E. Weaver as *Clypeaster bowersi*.

Dr. John C. Merriam of the University of California recognized the importance of this locality from a paleontological standpoint and had two large collections made there about 1911-1913. One of these was by Messrs. Kew and Buwalda; the other by Kew and English. As a result of these visits, the most extensive collections thus far taken were assembled.

In 1914 Dr. Kew published a paper on the echinoids of the region in which several new species were described. He also included a geologic sketch map and cross section of Coyote Mountain. He also published a list of the Mollusca which had been identified. Only ten of the names were given unqualifiedly and none of these were gastropods; all except four had been described from these deposits.

This paper was followed in 1916 by one by J. O. Nomland on Cretaceous and Tertiary corals of California and Oregon in which one species from Coyote Mountain was described.

In 1917 Dr. T. Wayland Vaughan published an extensive account of the corals collected in 1904 by Messrs. Mendenhall and Bowers. He made extensive comparisons with other faunas and gave a fairly complete resume of all previous work in the region. (It should be noted that the explanations beneath the two figures on Plate 93, Prof. Ppr. 98, No. 5, U. S. Geol. Sur. are reversed.)

Dr. R. E. Dickerson read a short paper before a meeting of the Geological Society of America in 1918 (published only in abstract form) in which previous views on relationships of the Coyote Mountain deposits are given. This was followed in the manuscript by a list of the Mollusca he had identified from the collections.

Many collections have been made in the region from time to time, the most important of which I have knowledge being the following:

1. The Blake collection which Conrad studied.
2. The Orcutt collections of 1888 and 1890, studied and reported upon by him.

3. The Fairbanks collection which went to the University of California and the corals of which were studied by Vaughan.

4. The Bowers collection of 1901, the corals of which were sent to Vaughan while the mollusks eventually came to the California Academy of Sciences.

5. The Mendenhall and Bowers collection of 1904 which went to the U. S. Geological Survey and the corals of which were studied by Vaughan.

6. The Kew and English collection of 1912 which went to the University of California.

7. The Kew and Buwalda collection of 1913 which went to the University of California. The echinoids of the last two collections were studied by Kew.

8. The Stephens and Sternberg collection of 1920 which went to the San Diego Society of Natural History.

9. The California Academy of Sciences collection of 1921 made by the writer.

10. Stanford University collection made at various times and by various collectors.

11. A private collection made at various times by Sternberg and distributed to several institutions.

GEOLOGY OF THE DISTRICT

During my visits to Coyote Mountain, I examined many of the cañons minutely, but my purpose was chiefly to search for fossils. Therefore, I am not in a position to add much to the two excellent accounts of structural conditions which have been published.⁴ The most important parts of these papers were quoted by Vaughan (U. S. Geol. Surv. Prof. Ppr. 98, pt. 5, 1917, pp. 355-360). In general, these observers agreed that Coyote Mountain was an island of granitic and metamorphic rocks, of possibly Carboniferous age at the time of deposition of the Tertiary sediments. This deposition was accompanied in its early stages by some volcanism of minor character. One of the most evident features as the mountain is approached, is the manner in which all strata dip away from

⁴ Mendenhall, *Journ. Geol.* Vol. 18, 1910, pp. 336-355. Kew, *Univ. Calif. Publ. Geol.* Vol. 8, 1914, pp. 39-60.

the center in every direction. Erosion has cut away many of the soft clay layers and left hard sandstone or oyster reefs projecting as isolated hills in "bad land" areas. Many of the reefs are composed almost entirely of organic calcite, chiefly oysters, firmly consolidated and in one place at least partially turned to marble. In other places, there are large areas completely covered with oyster shells, anomias, pectens and barnacles. These are weathered out free, and except for an etching from the wind-blown desert sand, are in a perfect state of preservation.

Much of the core of the mountain is composed of marble and quarrying operations on a prospective scale have been carried on at many places. Unquestionably some of it is very beautiful rock.

The best fossil-collecting locality is on the south side of the mountain, a little west of the center in a wash called Alverson Cañon. Fossils occur there in many kinds of sediments, but the preservation is notoriously bad. Many of them can only be had as casts, while most of the others are so badly crystallized that the finer details of sculpture are obscured. The richest layers are sandstone, firmly cemented with calcite. Extraction of fossils from this material was found to be exceedingly difficult except in a few favorably weathered surfaces.

AGE OF THE DEPOSITS

Various age determinations have been made of the Tertiary sediments on the flanks of Coyote Mountain usually referred to as "Carrizo Creek" which cuts through a portion of them. Conrad, with four species of Mollusca, thought the age was Miocene.

Orcutt in 1890 supposed it to be Cretaceous, basing the decision upon the oysters and corals.

Vaughan in 1900 with two species and a subspecies of coral gave the age as "doubtfully Cretaceous."

Arnold in 1906 called it Miocene and correlated with the Etchegoin of central California which he also called Miocene, but which has been determined to be lower Pliocene.

Vaughan in 1910 gave the age as lower Miocene as determined by Messrs. Dall and Arnold.

Kew in 1914 stated that "The echinoderm fauna seems to indicate a comparatively late age, as several of the forms are very closely related to species living in the Gulf of California at the present time." In 1920 he referred all of them to the Pliocene.

In 1916 Nomland referred the coralliferous beds to the Pliocene.

Vaughan in 1917 stated that "The fauna of Carrizo Creek is related to Pliocene and Post-Pliocene faunas of Florida and the West Indies and can scarcely be older than lower Pliocene."

Dickerson followed in 1918 with a Miocene age determination correlating the sediments with the Gatun formation of Panama.

It is quite evident that considerable diversity of opinion as to the age has existed. A critical study of the Mollusca contained in the various collections I have examined, leads me to agree that the age cannot be greater than lower Pliocene and I am much inclined to the belief that the greater portion is middle and upper Pliocene.

There appears to be good reason to suspect that more than one Pliocene formation is represented on the flanks of Coyote Mountain. Very little reason exists for the placing of the coral reef, the lowermost exposed fossiliferous stratum, with the great oyster reefs of the upper part.

NAMES OF FORMATIONS

For a long time the deposits about Coyote Mountain have been called "Carrizo Creek" beds, or "Carrizo" formation; the latter was proposed definitely in 1914 by Kew,⁵ but Vaughan⁶ has shown that these names are inapplicable because of prior use elsewhere. This is to be regretted, but it seems that current usage demands a different name. Since we are unable as yet to correlate definitely any of the fossil bearing strata with any named formation elsewhere, I would propose that it be known as the "Imperial Formation" in the future.

⁵ Univ. Calif. Publ. Geol. Vol. 8.

⁶ U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 367.

The type locality should be taken as the coral reef exposed in Alverson Cañon on the south side of the mountain.

This coral reef has a distinctive fauna. It is succeeded by about 200 feet of very fossiliferous calcareous sandstones for which I would propose the name "Latrania Sands." It is this formation which contains the large general assemblage of marine Mollusca, a representation which indicates the presence of pure ocean water.

Above the Latrania Sands there are enormous deposits of clay, the peculiar properties of which may make it of commercial value at some future time. In order that these may have a name for reference I would propose that they be called the "Coyote Mountain Clays." They are extensively developed over wide areas but the type locality has been selected in the foothills bordering the southeast slope of Coyote Mountain.

Above these clays, and interbedded with them near the top to some extent, are extensive deposits of oyster shells for which the name "Yuha Reefs" has been selected. The type locality has been chosen as a prominent hill made up of the material, thoroughly cemented and partially metamorphosed, located on the east end of the Coyote Mountain uplift. A gap between the hill and the mountain affords a good trail from Coyote Wells on the San Diego-El Centro Highway to the north side of the mountain. The same reefs are found on Yuha Buttes, Superstition Mountain, Signal Mountain, and especially near where Carrizo Creek flows out of the mountains to the westward.

The Yuha Reefs are followed by an enormous thickness of silt deposited in the freshwaters of the ancient Lake Coahuila, an appropriate name for which is the "Coahuila Silt." It is exposed where the San Diego-El Centro Highway crosses New River about a mile west of El Centro. The total thickness of these silts is not known but they contain freshwater fossils to the base of the exposure indicated.

Thus, according to the above nomenclature, Conrad's fossil mollusks came from the Yuha Reefs. Kew's echinoderms are from the Latrania Sands; and Vaughan's corals from the Imperial Formation. It is believed that further work will

necessitate further subdivision rather than a consolidation of the above formations.

In this connection it is proper to add that Coyote Mountain has been called "Carrizo Mountain" in some reports. Also Fish Creek Mountain, the next one to the north of Carrizo Creek, has been called "Black Mountain," "Barrett Mountain," and "Fish Mountain."

OIL POSSIBILITIES

At various times attempts have been made around the flanks of Coyote Mountain to obtain oil, but I think in every case, without adequate preliminary geological investigation. If this had been made, I can see no reason for the drilling of more than one well in that vicinity. This statement is based upon the following facts:

1. No adequate source of petroleum exists. While some exposed strata are very fossiliferous, all except the oyster reefs are far from being sufficiently so to be considered as a source of petroleum in commercial quantities. The oyster reefs have no adequate cover. The great deposits of shales and clay shales are barren of organisms. The basal marbles cannot be considered at all in this connection.

2. The structure about Coyote Mountain is monoclinal; all strata dip away from the mountain. There is no known place for oil to accumulate. There is only one possible exception to this statement within a radius of five miles of the mountain, to my knowledge. Yuba Buttes, five miles to the southeast, is evidently an anticlinal, dome-shaped fold. But it was tested to a depth of over 1100 feet many years ago without evidence of oil.

INDETERMINATE SPECIES

The various collections studied have contained a considerable number of species so poorly preserved that positive specific identification cannot be made. While it is true that leaving them out of the present list will give the impression that the complete fauna is smaller than it actually is, no useful purpose would appear to be served by including a lot of generic names.

The fauna of the Pliocene beds of Coyote Mountain is a large one, and if it could be seen in its entirety, it would approximate, probably, the present one of the Gulf of California in size; but induration has proceeded to such a degree that only a small portion can be obtained unless some new localities with better preservation are discovered. Mere names of genera, derived from fragments, do not give a satisfactory picture of a fauna, but they are sometimes included in lists as padding. Space is now too valuable to warrant such procedure unless some other purpose can be served.

Therefore, only those species have been included in the following pages which could be identified with reasonable assurance of their correctness. No doubt inexperience has thus caused the omission of some species which might have been included had the author been more familiar with related faunas. This loss, however, is believed to be more than offset by the inaccuracies which would have resulted from attempts to place the fragments in question.

COLLECTING STATIONS

The three largest collections studied have been appropriately numbered in the respective museums, and the following list is a transcript of the various localities from which each lot was obtained. Although collecting stations have been duplicated by the several collectors, the numbers have been kept separate, consistently, in the body of the paper, the institution to which each pertains being appropriately indicated by initial letters.

STATIONS OF THE UNIVERSITY OF CALIFORNIA

735. Near the center of the Yuha Buttes, Imperial County, California, and at the top of the anticline there; south of the main road from El Centro to San Diego; about four miles north of the Mexican boundary; W. S. W. Kew and W. E. English, colls.
736. About 200 yards south of the axis of the anticline in Yuha Buttes, Imperial County, California; W. S. W. Kew and W. E. English, colls.
737. South side of Coyote Mountain, Imperial County, California, in a wash heading northwest from the road near the base of the formation; W. S. W. Kew and W. E. English, colls. (Alverson Cañon.)

738. From two small washes on the west side of the cut made by the stream in which No. 737 is located, at the base of Coyote Mountain, Imperial County, California, west of the road from Coyote Wells to Carrizo Spring via Coyote Mountain; W. S. W. Kew, W. E. English and J. P. Buwalda, colls. (This locality is in a branch of Alverson Cañon, Original Nos. 4 and 55.)
739. At the head of the south branch of Alverson Cañon, Coyote Mountain, near the divide leading to Carrizo Creek, Imperial County, California; W. S. W. Kew and W. E. English, colls.
740. Alverson Cañon, Coyote Mountain, Imperial County, California, near the contact of lavas [?] and sandstones; W. S. W. Kew and W. E. English, colls.
2062. In wash halfway between Coyote Mountain and Carrizo Spring, Imperial County, California; Upper beds of formation; W. S. W. Kew and J. P. Buwalda, colls.; April, 1913.
2063. In Garnet Cañon, north side of Coyote Mountain, Imperial County, California; about halfway to head of cañon and from basal beds lying on the complex; W. S. W. Kew and J. P. Buwalda, colls.; May, 1913.
2064. At the head of Garnet Cañon, north side of Coyote Mountain, Imperial County, California; basal beds; W. S. W. Kew and J. P. Buwalda, colls.; May, 1913.
2065. Near the head of Garnet Cañon, Imperial County, California; hard shales containing gypsum; W. S. W. Kew and J. P. Buwalda, colls.; May, 1913.

Localities 735, 736, and 2062 are from the "Yuha Reefs"; the remainder are from the "Latrania Sands" as defined above.

STATIONS OF THE U. S. GEOLOGICAL SURVEY

3919. East end of Coyote Mountain, Imperial County, California; Stephen Bowers, coll.; 1904 (Original No. 165).
3921. "Barrett's Oil Well" about 20 miles north of the Mexican boundary, Imperial County, California; Stephen Bowers, coll. 1904 (Original No. 168). [This locality is near Carrizo Creek wash and on a direct line between Coyote Mountain and Fish Creek Mountain; See map of Mendenhall, reprinted by Vaughan.]
3922. At the head of Garnet Cañon on the north side of Coyote Mountain, Imperial County, California; Stephen Bowers, coll.; 1904 (Original No. 166).
3923. Alverson Cañon, on the south side of Coyote Mountain, Imperial County, California; Stephen Bowers and W. C. Mendenhall, colls.; 1904 (Original No. 164).
6836. Carrizo Creek, Colorado Desert, California, January, 1890.
6847. Ravine about one mile south of Alverson Cañon, Coyote Mountain, Imperial County, California; Stephen Bowers and W. C. Mendenhall, colls.; January 20, 1904 (Original No. 163).

[In addition to the above material, the U. S. National Museum probably contains some of the original specimens collected by the members of the Pacific Railroad Survey and studied by Conrad. There is also a collection of corals from Fish Creek Mountain, which has a direct bearing upon the present collections. It is No. 7616 (Original No. 167). (See Vaughan, U. S. Geological Survey Prof. Ppr. 98, 1916, p. 350.) Localities 3919, 3921, 6836 and 6847 are supposed to have come from the "Yuha Reefs"; localities 3922 and 3923 contain material from both the "Latrania Sands" and "Imperial Formation" as defined above.]

STATIONS OF THE CALIFORNIA ACADEMY OF SCIENCES

680. Alverson Cañon, Coyote Mountain, Imperial County, California; from coarse sandy limestone above coral reef.
681. Alverson Cañon, Coyote Mountain, Imperial County, California; from the coral reef which crosses the cañon toward its source.
682. From the first narrow, box cañon east of Alverson Cañon, Coyote Mountain, Imperial County, California.
683. From the second cañon east of Alverson Cañon, Coyote Mountain, Imperial County, California.
684. North side of Coyote Mountain, Imperial County, California; from cañon one-half mile north of road to marble quarry but west of red hills on north side of road.
685. Northeast corner of Coyote Mountain, Imperial County, California; from a bank 100 yards south of road to marble quarry; in the flat between red hills on the north and Coyote Mountain on the south.
686. One mile northwest of James Well, east of Coyote Mountain, Imperial County, California; from a high projection of a solid shell reef; the reef dips east about 30°.
687. From a clay shale layer which underlies the shell reef hill (No. 686), Coyote Mountain, Imperial County, California.
688. From a wash two miles west of James Well and one mile south of base of Coyote Mountain, Imperial County, California.
689. Oyster reef near same place as No. 688.
690. From first knoll northwest of the shell reef hill (No. 686), Coyote Mountain, Imperial County, California.
691. Uppermost layers one mile northwest of James Well and east of base of Coyote Mountain, Imperial County, California.
692. Oyster bed one-half mile northeast of James Well and two miles northeast of base of Coyote Mountain, Imperial County, California.
693. Yuha Buttes, Imperial County, California.

701. A miscellaneous collection of fossils received without definite locality data, other than Coyote Mountain, Imperial County, California, from California State Mining Bureau, collected by Dr. Stephen Bowers.

[All of the above Academy collections except No. 701 were made by the writer in January, 1921. Localities 680, 682-685 are from the "Latrania Sands"; locality 681 is from the Imperial Formation; localities 686-693 are from the "Yuha Reefs" as defined above.]

BIBLIOGRAPHY

The following list of titles is not intended to be complete for the whole of the desert region of southeastern California. Only those references are given which pertain to the geology of the vicinity of Coyote Mountain, and which have been used in the preparation of this paper. A long list which deals with other phases of the interesting region, particularly Imperial Valley and the Salton Sea, has been intentionally omitted because they have no direct bearing on the paleontology of the district here treated. One exception is made in the case of a detailed account of desert trails and watering places, a publication of incalculable value to any one who may make explorations of any kind in the region.

- ARNOLD, RALPH—The faunal relations of the Carrizo Creek Beds of California. *Science*, n. s., Vol. 19, 1904, p. 503.
-—Paleontology of the Coalinga District, Fresno and Kings counties, California. *U. S. Geol. Surv. Bull.* 396, 1909. On p. 44 the Carrizo Creek formation is correlated with the Etchegoin of San Joaquin Valley upon the presence of *Pecten deserti* Conrad.
- BLAKE, WM. P.—Pacific Railroad Survey Reports, Vol. 5, 1857, pp. 108, 120-123. On the pages cited is given an account of the occurrence of the fossils at the mouth of Carrizo Creek.
- BOWERS, STEPHEN—Reconnaissance of the Colorado Desert Mining District. California State Mining Bureau, separate publication, 1901, 19 pp.
- BROWN, J. S.—Routes to Desert Watering Places in the Salton Sea Region, California. *U. S. Geol. Survey Water Supply Paper* No. 490-a, 1920. The same, much enlarged and with a great deal of general information, by the same author appeared as "The Salton Sea Region of California." *U. S. Geol. Surv. Water Supply Paper* No. 497, 1923, pp. 1-292; maps.

- CONRAD, T. A.—Pacific Railroad Survey Reports, Vol. 5 (Geology), 1857, App. 2, pp. 325-326, pl. 5. Four species of fossil Mollusca are described from a locality near where Carrizo Creek flows out of the mountains on the west to the valley floor. A footnote on the title page states that the descriptions were originally published in 1855 in the appendix to the Preliminary Report on Geology by Wm. P. Blake. See House Executive Document, No. 129, 33rd Cong. 1st Sess. 1855.
- DICKERSON, R. E.—Mollusca of the Carrizo Creek Beds and their Caribbean Affinities. (Abstract), Geol. Soc. Am. Bull. 29, 1918, p. 148.
- FAIRBANKS, H. W.—Eleventh Ann. Rept. Calif. State Mineralogist, 1893, pp. 88, 90.
- KEW, WM. S. W.—Tertiary Echinoids of the Carrizo Creek Region in the Colorado Desert. Univ. Calif. Publ. Bull. Dept. Geol. Vol. 8, 1914, pp. 39-60.
- Cretaceous and Cenozoic Echinoidea of the Pacific Coast of North America. Univ. Calif. Publ. Geol. Vol. 12, No. 2, 1920. The Coyote Mountain echinoderms are redescribed in this paper.
- MENDENHALL, W. C.—Notes on the Geology of Carrizo Mountain, San Diego County, California. Journal of Geology, Vol. 18, 1910, pp. 336-355.
- MERRILL, J. H.—Geology and Mineral Resources of San Diego and Imperial counties (California). Advance Report Calif. State Mineralogist, Dec. 1914, pp. 1-113. The same was reprinted in 1916 as a part of the 14th Ann. Rept. Calif. St. Min. for 1913-1914 pp. 633-743. Much information on the geology of Imperial County is contained in this report. On p. 105 is reproduced a photograph showing borings of marine mollusks in marble on the slopes of Coyote Mountain. At the end of the paper, 20 references to places in the State Mining Bureau's publications are cited which deal with the geology or mineral resources of Imperial County; most of these treat of mining operations.
- NOMLAND, J. O.—Corals from the Cretaceous and Tertiary of California and Oregon. Univ. of Calif. Publ. Bull. Dept. Geol. Vol. 9, 1916, pp. 59-76.
- ORCUTT, CHARLES R.—Geology of the Colorado Desert. 10th Ann. Rep. Cal. State Min. for 1890, pp. 899-919. A bibliography and long account of the fossils are given.
-—The Colorado Desert. West Am. Scientist, Vol. 12, No. 102, 1901.
- VAUGHAN, T. W.—A Californian Tertiary Coral Reef and its bearing on American Recent Coral Faunas. Science N. S. Vol. 19, 1904, p. 503.
-—The Eocene and Lower Oligocene Coral Faunas of the United States. U. S. Geol. Surv. Monog. No. 39, 1900. On pp. 142 and 151, pls. 15, 17, three Imperial County corals are described.

- VAUGHAN, T. W.—In Arnold, Tertiary and Quaternary Pectens of California. U. S. Geol. Surv. Prof. Ppr. 47, 1906. On p. 22, is given a list of Coyote Mountain fossil corals; some new names without descriptions appear.
-—The Reef-coral Fauna of Carrizo Creek, Imperial County, California, and its Significance. U. S. Geol. Surv. Prof. Ppr. 98, pt. 5, 1917, pp. 355-386, pls. 94-102. This important paper gives a complete resume of the geology of the district up to the date of publication.
- WEAVER, C. E.—New Echinoids from the Tertiary of California. Univ. Calif. Publ. Geol. Vol. 5, 1908, pp. 271-274.

GASTROPODA

1. *Architectonica quadriceps* Hinds

Plate 20, figures 5, 6

Specimens examined

Locality	Collection	Number
55	U.C.	5
738	U.C.	3
681	C.A.S.	1
6847	U.S.G.S.	1

The best preserved one of the above (Loc. 738, U.C.) has been figured. All have been crystallized and this has tended to obscure the fine sculpture. In size, shape, and sculpture the fossils agree very well with the figure of *quadriceps* given by Tryon,⁷ but the spiral cords are not broken into beads as in the Gulf of California species commonly called *granulata* S. *quadriceps* was described from Panama.⁸

2. *Bullaria striata* Bruguière

Plate 20, figure 9

Bulla striata BRUG. PILSBRY, Man. Conch. Vol. 15, 1893, p. 332, pl. 37, figs. 42-46.

Bullaria striata attenuata DALL, Trans. Wagner Free Inst. Sci. Vol. 3, pt. 2, 1892, p. 219, pl. 13, fig. 10a.

⁷ TRYON, Man. Conch. Vol. 9, 1887, p. 10, pl. 4, figs. 39, 40.

⁸ HINDS, Proc. Zool. Soc. London, 1844, p. 23.

Bulla paupercula SOWERBY, Quart. Journ. Geol. Soc. London, Vol. 6, 1849, p. 52—GABB, Trans. Amer. Phil. Soc. Vol. 15, 1873, p. 246—GUPPY, Quart. Journ. Geol. Soc. Lond., Vol. 32, 1876, p. 518.

Bullaria paupercula SOWERBY, MAURY, Bull. Am. Pal. No. 29, 1917, p. 182, pl. 3, fig. 8.

Specimens examined

Locality	Collection	Number
680	C.A.S.	1
682	C.A.S.	13
3922	U.S.G.S.	2
3923	U.S.G.S.	2
6847	U.S.G.S.	5

B. striata is a species now found living in the Mediterranean Sea and Pilsbry has shown that the West Indian living shells, usually called *B. amygdala* Dillwin, cannot be separated from it.

Dall⁹ listed the species as *striata* from the Bowden, Jamaica deposits, which were then thought to be Oligocene in age. Maury, however, continued to use the name *paupercula* for the fossils from Santo Domingo because "Sowerby's species has been so much used it seems best to retain it for the fossil."

The figures of Pilsbry are as nearly identical with the California fossils as it appears necessary for them to be. Shape and size are very nearly the same. The fossils are somewhat eroded and crystallized, but it is possible to see that there were six spiral lines on the base and three near the apex of those best preserved. The apical umbilicus is wide and the angulation of the shell there is marked. The specimen illustrated herewith measures 26.1 mm. in altitude and 14 mm. in diameter. The loosening of the outer layer of the shell has produced a columellar channel which, being artificial, should be ignored in comparisons. There does not appear to be a Gulf of California living "analogue" of this West Indian form, nor has anything like it been recorded from the Isthmuses of Tuhauntepec and Panama fossil deposits. Whether present-day taxonomists would give the Mediterranean form so wide a geographic and stratigraphic range as this cannot be answered, but, accepting the work of the past, no biologic reason could be discovered in the fossils to warrant their separation.

⁹ Trans. Wag. Free Inst. Vol. 3, pt. 6, 1903, p. 1583.

3. *Cancellaria obesa* Sowerby

Plate 20, figures 3, 4

Specimens examined

Locality	Collection	Number
701	C.A.S.	1
4	U.C.	1
738	U.C.	36
..	S.D.S.N.H.	5

Shape and sculpture in this series are variable, but less so than among an equal number of living shells from Magdalena Bay, Lower California. Some of the fossils are almost smooth on the body whorls, a senile character apparently, while others are heavily cancellated. Between the two forms, there is every stage of intergradation. The name, *C. urccolata* Hinds appears to have been applied to the strongly marked forms, and if this name be admitted, it should certainly be applied to some of the above fossils.

The largest of the above listed specimens (S. D. S. N. H. coll.) is 45 mm. in altitude and 23 mm. in diameter, but living specimens have been seen which considerably exceed these dimensions.

The Gatun species, *C. dariena* Toulou, ¹⁰ seems to be strongly marked constantly, and differs otherwise from the Coyote Mountain fossils.

4. *Cassis subtuberosa* Hanna, new species

Plate 20, figure 8; plate 29, figures 2, 3

Shell with a single row of low, close-set tubercles around the periphery of the last half of the last whorl; spiral striation absent but last part of last whorl irregularly longitudinally ribbed; spire moderately elevated, conical; columellar face and expanded outer lip roughly triangular in shape; 11 low lamellar teeth on the outer lip; columellar face irregularly ridged in the lower part; the upper projecting angle somewhat eroded due to wear before the specimen was preserved.

The species is most closely related to *C. tuberosa* Linnæus. In addition to the type specimen two others are in the series of shells examined, but only one is of value in defining the species.

¹⁰ Jahr. K. K. Geol. Reich., Vol. 58, 1908, p. 703, pl. 25, fig. 13, pl. 28, fig. 2.

This is a younger individual than the type and three indistinct rows of tubercles are visible on the body whorl. This suggests *C. sulcifera* Sowerby,¹¹ but all three rows in that species continue to develop to maturity.

The upper projection of the enamelled columellar face is extended almost exactly in the same proportion in the younger individual of *subtuberosa* as in *C. tuberosa*. This specimen indicates that there may be intergradation between the fossils and living forms if sufficient material were at hand for study. In neither of the fossils are the tubercles massive nor do the earlier ones show in the aperture of the shell as in *C. tuberosa*.

Type and paratype: In the collection of the University of California from **Loc. 738, Alverson Cañon, Coyote Mountain, Imperial County, California.** Another very poorly preserved specimen is listed under locality 701 (C.A.S.). Casts of the type and paratype are Nos. 1799 and 1800 (C. A. S. coll.).

The finding of this fossil *Cassis* is believed to be the first definite record of one of the larger species of the genus on the west coast of North America, either living or fossil. So far as I am aware, none has been found in the Tertiary deposits of the West Indies or the southern states, although three species are found living there at the present time. *C. tuberosa* was not found by F. M. Anderson in any of the fossil deposits of Colombia or the Isthmus of Panama, but recent specimens were secured by him at the former place. One of these has only five tubercles on the periphery of the last whorl. Two other specimens in the California Academy of Sciences from the Bahama Islands have eight and six respectively. In every case these assume the character of blunt spines and are rather distantly separated.

5. *Cerithium incisum* Sowerby

Lampania incisa SOWERBY, Thes. Conch. Vol. 2, 1855, p. 868, fig. 152.

Cerithium incisum SOWERBY, Tryon, Man. Conch. Vol. 9, 1887, p. 142, pl. 26.

Four specimen from Loc. 682 (C.A.S.) agree with the shell which Tryon has figured under the above name. The best one is fairly well preserved, but the upper part of the spire is lacking.

¹¹ Quart. Journ. Geol. Soc. Lond., Vol. 6, 1849, p. 47, pl. 10, fig. 1. MAURY, Bull. Am. Paleo. No. 29, 1917, p. 110, pl. 18, figs. 1, 2, 3.

6. *Conus fergusoni* Sowerby

Plate 21, figures 6, 7

Conus fergusoni SOWERBY, Proc. Zool. Soc. Lond., 1875, p. 145, pl. 15, fig. 1.

(?) *Conus mollis* BROWN & PILSBRY, Proc. Acad. Nat. Sci. Phila., 1911, p. 343, pl. 23, fig. 1 (Gatun formation, Isthmus of Panama).

A single adult and 17 young of a large cone from Loc. 738, have been referred to this living species of the Gulf of California and southward. The large one has been somewhat crushed out of shape and otherwise is imperfect, but the correctness of the identification is fairly certain. This specimen is 89.7 mm. in altitude and 52 mm. in greatest diameter. While the identity of it with the living form is advisable, there is considerable doubt as to the correct name which should be applied. *C. fergusoni* was described from a living specimen from Panama and has since been found at numerous localities on the west coast. The California Academy of Sciences' collections contain a good series. In them there are also several fine specimens from the Gatun beds of the Isthmus of Panama. They appear to be identical with the species from there which was named *C. mollis* by Brown and Pilsbry. Both series show some variation in height of spire and the sculpture between the sutures.

In the original description of *C. mollis*, comparison is made with *Conus haytensis* Sowerby,¹² a species which was described without illustration from the Santo Domingo Miocene. Maury,¹³ however, figured it and remarked upon the closeness of *C. mollis* to it. If they should prove to be the same, as seems likely, *C. haytensis* will replace both names, *fergusoni* and *mollis*.

The young examples from locality 738 are all more or less imperfect and could, with equal propriety, be determined as any one of a dozen named species. Through crystallization they have lost their finer sculpture and many of them are crushed and broken. The shape does not deviate from that of *fergusoni* sufficiently to be noted herein.

¹² Quart. Journ. Geol. Soc. Lond., Vol. 6, 1849, p. 44.

¹³ Bull. Am. Pal. No. 29, 1917, p. 35, pl. 5, fig. 1.

7. *Conus planiliratus* Sowerby

Conus planiliratus SOWERBY, Quart. Journ. Geol. Soc. Lond., Vol. 6, 1849, p. 44—MAURY, Bull. Am. Paleo. No. 29, 1917, p. 47, pl. 7, fig. 10.

At locality 738 nine small specimens of *Conus* were collected. All are imperfect, being badly crystallized and the sculpture is in no condition to warrant very definite identification. They seem to be closer to this Miocene species of West Indian and Panama deposits than to any other. In the most perfect specimen there are about 20 spiral grooves, but whether the ridges have been cut transversely, it is impossible to ascertain. The shape of the spire is about the same as that of *planiliratus* of which the California Academy of Sciences has a large series from Panama. The largest specimen from Coyote Mountain, however, is only 19 mm. in altitude and 10.5 mm. in greatest diameter.

8. *Conus regularis* Sowerby

Plate 21, figure 8

Conus regularis SOWERBY, Conch. Ill. 1841, fig. 45—DALL, Proc. U. S. Nat. Mus., Vol. 38, 1910, p. 221.

Specimens examined

Locality	Collection	Number
682	C.A.S.	11
55	U.C.	4
6847	U.S.G.S.	2

The above name is applied to the Coyote Mountain fossils with the meaning attached to it given by Dall in the publication, cited above, and not as defined by Tryon.¹⁴ Most of the above specimens show traces of bold square maculations very distinctly. In the fossils, the color of these spots is brown, in the living shells, red.

¹⁴ Man. Conch., Vol. 4, 1884, p. 37, pl. 11, figs. 98, 99, 100, 1, 2.



9. *Crepidula onyx* Sowerby

One specimen collected by Mr. Frank Stephens at Coyote Mountain is in the collection of the San Diego Society of Natural History. It is rugose like one figured by Tryon.¹⁵

10. *Crucibulum spinosum* Sowerby*Specimens examined*

Locality	Collection	Number
680	C.A.S.	2
682	C.A.S.	1
51	U.C.	2
3922	U.S.G.S.	1

All of the above specimens are somewhat imperfect, but no characters could be discovered by means of which they could be distinguished from living specimens of this widespread and highly variable species.

11. *Fasciolaria princeps* Sowerby*Specimens examined*

Locality	Collection	Number
56	U.C.	1
738	U.C.	1
688	C.A.S.	1
701	C.A.S.	1
3922	U.S.G.S.	1
3923	U.S.G.S.	1

The best preserved of the above specimens (Loc. 738 U.C.) are referred to *F. princeps* without hesitation. The species is found living from Magdalena Bay, Lower California, to Panama, and a considerable series has been available for comparison. It is understood that the shells of the species are almost indistinguishable from those of *F. papillosa* (*F. gigantea* Keiner) of the east coast, but considerable differences exist in the operculums. Under the circumstances, it seems logical to refer the fossils to the western form.

¹⁵ Man. Conch., Vol. 8, p. 128, pl. 37, fig. 37.

12. *Ficus decussata* Wood

Plate 21, figure 9

Specimens examined

Locality	Collection	Number
55	U.C.	2
682	C.A.S.	2

One of the specimens from the last lot mentioned above is fairly well preserved; it measures 30 mm. in altitude; 22.5 mm. in diameter. The other specimens are small casts not readily determinable with certainty, but presumably the same. Even the best preserved has so crystallized that the minute sculpture cannot be discerned and apical characters have been lost. Burnett Smith¹⁶ in treating of the morphology of the genus gave apical characters for the separation of most of the living species, but did not indicate the constancy of sculpture in a large series of shells from one locality.

East American paleontologists do not seem to have adopted the genus-name *Ficus* Bolten, in place of *Pyrula* Lamarck, as proposed by Dall¹⁷ in 1909. Western students have generally accepted the change and their example is followed herein, without, however, giving consideration to the merits of the case.

F. decussata is the name generally used for the common species found living in the Gulf of California. A large series collected in 1921 by the Expedition from the Academy has been available for comparison and within the lot, variation in sculpture is sufficient to cover the Coyote Mountain fossils.

13. *Littorina varia* Sowerby

Two specimens from Loc. 6836 (U.S.G.S.) have been referred to this exceedingly variable species. They show no trace of spiral sculpture. The best one is figured and measures, altitude 25.5 mm.; diameter 20 mm.

The species belongs to a tropical group which is exceedingly widespread. The east coast representative is *L. scabra* Linnaeus; this can scarcely be separated from *varia* with certainty.

¹⁶ Proc. Acad. Nat. Sci. Phila., 1907, pp. 208-219, pl. 17.

¹⁷ U. S. Geol. Surv. Prof. Ppr. 59, 1909, p. 74.

14. *Malea ringens* Swainson

Plate 21, figure 10

Specimens examined

Locality	Collection	Number
53	U.C.	1
55	U.C.	22
56	U.C.	2
738	U.C.	3
739	U.C.	3
680	C.A.S.	3
681	C.A.S.	1
682	C.A.S.	1
701	C.A.S.	4
3919	U.S.G.S.	2
3922	U.S.G.S.	1
3923	U.S.G.S.	3
6847	U.S.G.S.	1

This large series consists of some well preserved specimens and others which are merely casts. The largest is only 75 mm. in altitude, which is small as compared with some recent specimens from the Gulf of California. The number of spiral ribs varies from 13 to 20 and there appear to be no characters for specific separation of the fossils from living specimens.

The name *M. camura* was given to a fossil from Santo Domingo in 1866¹⁸ and Gabb¹⁹ has stated that it is the same as *M. ringens*. As *camura*, Maury²⁰ has figured it from Santo Domingo, and it has been listed under that name from Gatun.²¹ The two forms are certainly very close, perhaps identical.

15. *Mitra sulcata* Swainson

Two imperfect specimens from Loc. 738 (U.C.) have been referred to this species in the sense in which Tryon²² used the name. The preserved sculpture is identical with that of living specimens from the west coast of Central America which are available for comparison.

¹⁸ GUPPY, Quart. Journ. Geol. Soc. London, Vol. 22, 1866, p. 287, pl. 17, fig. 9.

¹⁹ Trans. Am. Phil. Soc., Vol. 14, 1873, p. 223.

²⁰ BULL. 29, Am. Paleol., 1917, p. 112, pl. 19, fig. 3.

²¹ BROWN & PILSBRY, Proc. Acad. Nat. Sci. Phila., 1911, p. 356.

²² Man. Conch., Vol. 4, 1882, p. 139.

16. *Mitrularia equestris* Linnæus

Five casts of what appeared to be this species were collected on Coyote Mountain by Mr. Frank Stephens for the San Diego Society of Natural History.

17. *Modulus unidens* Lister

Three specimens from locality 6847 (U.S.G.S.) and seven from locality 682 (C.A.S.) are almost certainly referable to this variable species found living in the Gulf of California as well as on the east coast. All are crystallized so that the finer sculpture cannot be seen, but they agree with small specimens of *unidens* in shape. The margin is rather sharply carinate and the base has about five spiral cords. The largest specimen is five mm. in diameter. The tooth on the columella does not differ from that of living specimens from the Gulf of California.

18. *Natica unifasciata* Lamarck*Specimens examined*

Locality	Collection	Number
738	U.C.	7
682	C.A.S.	2
6847	U.S.G.S.	3

These specimens appear to belong to *unifasciata* as represented in collections available from Panama northward and by fossils from the Pleistocene deposits of Magdalena Bay, Lower California. Nevertheless the identification is attended with some uncertainty due to the difficulties of determining species in the genus and the comparatively poor preservation of the Coyote Mountain fossils.

19. *Natica uber* Valenciennes

Of this species there are 15 specimens from locality 738 (U.C.), one from locality 6847 (U.S.G.S.) and four from locality 682 (C.A.S.). It is known from Pleistocene deposits of the west coast of Lower California, the Galapagos Islands

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and Payta, Peru, and lives now from the Gulf of California as far south as Callao, Peru, according to Dall.²³

20. *Nerita scabricostata* Lamarck

A fragment of a *Nerita* 10 mm. across came from locality 738 (U. C.). Only the upper surface of the first two whorls is preserved. The sculpture of this is the same as of *N. scabricostata*, a living species found from the Gulf of California to Panama.

21. *Neritina picta* Sowerby

Eleven specimens of this species came from locality 6847 (U.S.G.S.) and 77 from locality 682 (C.A.S.). This large number shows, as usual in the species, considerable variation in form. In many of them the color is preserved and corresponds fairly well with that of living *N. picta* from the Gulf of California and southward.

22. *Oliva spicata* Bolten

Plate 21, figures 4, 5

Specimens examined

Locality	Collection	Number
6847	U.S.G.S.	5
738	U.C.	70
682	C.A.S.	8
..	S.D.S.N.H.	9

This large series contains no variations which are not found in a series of recent specimens of equal size from the Gulf of California. The form named *angulata* by Lamarck does not seem to be entitled to even subspecific rank because it is found with typical *spicata* and there appears to be perfect intergradation between the two. This is true of the fossils as well as the recent specimens.

The east coast analogue of this species is *O. reticularis* Lamarck. It likewise is subject to considerable, but less variation and in a large series intergradation with *spicata* is

²³ Proc. U. S. Nat. Mus., Vol. 37, 1910, p. 235.

thorough, particularly when the fossils are considered. Since the latter name has precedence the eastern shells will probably eventually take a subspecific name.

The synonymy of North American living species of *Oliva* has been thoroughly worked out by Johnson,²⁴ Mazyck²⁵ and Vanatta.²⁶

The fossil forms exhibit the great range of variation in size for which the recent species is known. The largest specimen in the collections measures 78.5 mm. in altitude and 38.3 mm. in diameter. Another broken one was 45 mm. in diameter. The large specimens show a tendency to have an angulated periphery. Johnson²⁷ has listed 27 specific and subspecific names which have been applied to living specimens.

23. *Olivella gracilis* Broderip and Sowerby

At Loc. 738, there was obtained a single badly broken specimen of a slender *Olivella*, having no characters distinct from the recent species of the Gulf of California.

24. *Solenosteira anomala* Reeve

Plate 20, figures 1, 2

Nine specimens which have been identified as this species came from locality 738 (U.C.). They are the same as Böse²⁸ listed and figured as *Melongena mengeana* Dall, from Paso Real cerca de Tuxtepec, Oaxaca deposits which he called Pliocene. The species lives on the west coast of Mexico at the present time and is found living and in Pleistocene beds at Magdalena Bay on the Pacific side of the Peninsula of Lower California. The fossils from Imperial County, California are identical with *S. anomala* as figured by Tryon²⁹ and represented by various specimens in the collection of the California Academy of Sciences. Tryon called the species a synonym of *Melongena pallida* (Brod. & Sowby.), but the differences

²⁴ Nautilus, Vol. 24, 1910-11, pp. 49, 64, and 121; Nautilus, Vol. 28, 1915, pp. 97 and 114.

²⁵ Nautilus, Vol. 28, 1915, p. 139.

²⁶ Nautilus, Vol. 29, 1915, p. 67.

²⁷ Naut., Vol. 28, 1915, p. 115.

²⁸ Bull. Inst. Geol. Mex. No. 22, 1906, p. 40, pl. 4, figs. 25, 26.

²⁹ Man. Conch., Vol. 3, 1881, p. 109, pl. 42, figs. 212, 213.

seem sufficiently great to be recognized. It is true, however, that several allied species of the group form an intergrading series.

25. *Strombus galeatus* Swainson

Specimens examined

Locality	Collection	Number
738	U.C.	2
680	C.A.S.	2
682	C.A.S.	2
701	C.A.S.	2
3923	U.S.G.S.	2

Most of these specimens have weathered out as internal casts, but size and shape are so nearly identical with living ones of this abundant Gulf of California species that they are unhesitatingly classed as the same.

26. *Strombus gracilior* Sowerby

Four specimens, some of which are well preserved, have come from localities 682 and 701. They do not differ in any noteworthy feature from recent and fossil shells in the collection from Magdalena Bay, Lower California, and a very large series collected in the Gulf in 1921 by Dr. Fred Baker.

27. *Strombus obliteratedus* Hanna, new species

Plate 20, figure 7

Shell similar to *Strombus granulatus* Gray but shorter and stouter; a row of prominent spines situated on the shoulder of all the whorls; this is succeeded on the body whorl by another row, below; although these are smaller than the shoulder row, they are much more pronounced than the middle row of nodules on the body whorl of *S. granulatus*.³⁰ The third and lowermost row of nodules on the latter is replaced in *S. obliteratedus* by a spiral ridge; between this and the rows of spines, there is no indication of spiral sculpture which is so pronounced in the recent species; no granulation is present on the

³⁰ Tryon, Man. Conch., Vol. 7, 1885, p. 110, pl. 3, fig. 2.

inside of the outer apertural margin in the type or any of the other specimens which are well enough preserved to show it. Altitude 61 mm.; diameter, 45 mm.

Type: No. 1809, Mus. Calif. Acad. Sci., from Loc. 682, **Alverson Cañon, Coyote Mountain, Imperial County, California**; G. D. Hanna, coll.

<i>Specimens examined</i>		
Locality	Collection	Number
680	C.A.S.	1
682	C.A.S.	6
701	C.A.S.	17
738, 53, 55, 56	U.C.	5
6847	U.S.G.S.	3
..	S.D.S.N.H.	1

While having undoubted close relationship with *S. granulatus* this species does not appear to intergrade with it in the important characters mentioned.

28. *Terebra gausapata* Brown & Pilsbry

Plate 22, figures 4, 5

One specimen was found at Loc. 738 (U.C.). It is very well preserved as shown by the figure herewith. Its identity with the species described by Brown & Pilsbry³¹ is not doubted. Of that species there are four specimens from Gatun in the California Academy of Sciences and some of them do not differ appreciably from the one from Imperial County, California. Brown & Pilsbry apparently had but a single specimen upon which to base their original description and therefore were unable to make any statement as to the variation or the relationship of the species. Attention is therefore called to the fact that the spiral striation which they mention as being present on the sutural band can scarcely be discerned in some specimens while in others it is very plain. The number of ribs on each whorl varies from 14 to 18 in specimens from Gatun and the one from southern California has 20. Spiral threads below the sutural band vary in number from three to five.

³¹ Proc. Acad. Nat. Sci. Phila., 1911, p. 340. pl. 22, figs. 8, 9.

Some specimens of *T. pedroana* Dall have convex spires like *T. gausapata*, but they are rare and differ in sculpture. So far as a large series of the former show, the two species cannot be connected by a series of intergrades. The fossils seem closer to the east coast Pliocene and recent species, *T. dislocata* (Say) than to the west coast form. *T. martini* English, from the Fernando Pliocene of California is a shell similar in size to *gausapata* but the vertical ribbing is much more pronounced in most specimens and the spiral lines are obsolete or nearly so.

29. *Terebra protexta* Conrad

Terebra protexta CONRAD, Proc. Acad. Nat. Sci. Phila., Vol. 3, 1843, p. 26—
TRYON, Man. Conch., Vol. 7, 1885, p. 25, pl. 6, fig. 98.

A single poorly preserved specimen of a *Terebra* was secured at Loc. 682 (C.A.S.) which has the very fine ribbing of this common species of Florida. There is no species known from the west coast of America at the present time which appears to approach this condition. The specimen did not exceed 10 mm. in length when it was perfect.

30. *Turris albida*(?) Perry

Specimens examined

Locality	Collection	Number
738	U.C.	6
6847	U.S.G.S.	1

The last measures 34.5 mm. in length and 19 mm. in width. If *T. albida* includes all of the variations which Dall⁸² and Maury⁸³ attribute to it then certainly it must include the specimens from Imperial County, California. Of the numerous variations the latter resembles most the one figured by Maury⁸⁴ as *T. a. barretti* (Guppy)⁸⁵ from the Miocene of Jamaica. The range of the species is given as from the Oligocene of Vicksburg, Mississippi, through the various Tertiary horizons of the West Indies, Florida and the Isthmus of Panama to the Recent. A large series of fossils from Gatun shows no such

⁸² Trans. Wag. Inst., Vol. 3, 1890, pt. 1, p. 28, pl. 4, fig. 8a.

⁸³ Bull. 29, Am. Paleo., 1917, p. 214, pl. 8, figs. 4-8.

⁸⁴ op. cit. fig. 5.

⁸⁵ Quart. Journ. Geol. Soc. London, Vol. 22, 1866, p. 290, pl. 17, fig. 6.

range of variation as Maury has figured, and they have more numerous ribs and are nearer uniform in size than the specimens from California. If these latter were not imperfect, it would be possible to say definitely whether they were the same, but they all lack canals, and, moreover, the shell substance is crystallized so that the finer sculpture is obliterated. No west coast species is known with which comparison can be made.

31. *Turritella imperialis* Hanna, new species

Plate 21, figures 1, 2, 3

Shell robust, slender, apical angle from 10° to 12° ; suture well impressed; whorls deeply constricted in the middle, thus forming spiral ridges, the upper of which is slightly the larger; each ridge slopes gently to the center and to the suture; both are indistinctly noded in the type specimen; in others nodes are much more evident; between the two ridges there are four faint spiral threads in the type; in some specimens these are scarcely visible and in others they are stronger, varying in number from two to six; aperture circular with the exception of the deep constriction between the two ridges.

Type: In the Univ. Calif. Coll. from Loc. 738 (U. C.) Coyote Mountain, Imperial County, California; collected by W. S. W. Kew. A cast of the type is preserved as No. 1811, Mus. Calif. Acad. Sci. collection of type material.

The type specimen is 55 mm. long and 25 mm. in diameter. The entire length of this specimen was about 125 mm.

Specimens examined

Locality	Collection	Number
738	U.C.	62
6847	U.S.G.S.	3
680	C.A.S.	1
681	C.A.S.	6
682	C.A.S.	4
683	C.A.S.	3
685	C.A.S.	8
688	C.A.S.	1
701	C.A.S.	4

This species undoubtedly belongs to a group which attained maximum development in the Miocene and Pliocene of the east coast from Maryland to the West Indies. Variation among them has been so great that many names have been applied. Dall³⁶ has stated that these . . . "will probably be diminished when sufficient material has been brought together and carefully studied." On actual comparison of the western shells with Miocene material from the Chipola Marls of Florida some specimens of the latter are found which approach very closely. These I take to be *T. terebriformis* Dall,³⁷ an unfigured species. The only observable difference which appears to be constant is the lack of nodes on the spiral ridges. Size, shape and other sculpture appear to be identical.

The representative of the group in the Gatun formation of Panama is *T. altilira* Conrad,³⁸ the spiral ridges of which are high, and very decidedly crenulated. In no instance is intergradation with the California specimens approached.

Another closely related Miocene species is *T. tornata* Guppy³⁹ of Santo Domingo. The ridges on that species also are beaded and it appears never to reach such a large size as the others which have been mentioned.

From the Pliocene of Florida comes the large species, *T. perattenuata* Heilprin⁴⁰ which belongs to the same group but appears to differ from the southern California species to a greater extent. In it there is a greater tendency to accessory spiral ribs, some of them almost equaling in strength the two major ones.

Species of undoubted alliance are not lacking in present seas although none of them appears to reach the large size of the fossils. Thus *T. exoleta* Linnæus of the Gulf of Mexico and *T. cooperi* Carpenter of the west coast are similar in general form although both appear to be constantly different. The spiral ridges are much less heavy but they remain just two in number. The latter species has been found in Pliocene deposits of Lower California, as well as living.⁴¹

³⁶ Trans. Wag. Free Inst., Vol. 3, pt. 2, 1892, p. 316.

³⁷ op. cit., p. 311.

³⁸ For a full discussion of this species see BROWN & PILSBRY, Proc. Acad. Nat. Sci. Phila., 1911, p. 358.

³⁹ See MAURY, Bull. Am. Paleo. No. 29, 1917, p. 294, pl. 48, fig. 15.

⁴⁰ Trans. Wag. Free Inst., Vol. 1, 1887, p. 88, pl. 8, fig. 13—DALL, op. cit., Vol. 3, pt. 2, 1892, p. 316, pl. 16, figs. 5, 9.

⁴¹ See DALL, Trans. Wag. Free Inst., Vol. 3, 1892, pt. 2, p. 316—Tryon, Man. Conch., Vol. 8, 1886, p. 200, pl. 61, fig. 61.

There is another living species, a single specimen of which was dredged near the mouth of the Gulf of California, *T. mariana* Dall⁴² which appears from the figure to belong to the same group.

32. *Vasum cæstum* Broderip

<i>Specimens examined</i>		
Locality	Collection	Number
6847	U.S.G.S.	1
680	C.A.S.	1
682	C.A.S.	1
..	S.D.S.N.H.	1

This species has been recorded living from Mazatlan, Mexico, by Carpenter⁴³ and from San Diego, California by Dall.⁴⁴ Several conchologists, including Tryon,⁴⁵ have considered it identical with the east coast living species, *V. muricatum* (Born) and it is possible that if there were good series including fossils from both sides, available for study, no differences of a constant character could be found. I have had no living specimens from the west coast for comparison, but the only difference between the fossils and living east coast material seems to be in the weaker spirals of the former. The specimen from the San Diego Society of Natural History shows only a ridge for the anterior row of spines. It is badly broken but measures 93 mm. in altitude and 83 mm. in diameter. The U. S. Geological Survey specimen has a single row of spines. And the young example from locality 682 (Calif. Acad. Sci.) has a row of spines with a ridge below. The columellar plaits number either four or five. With a large series of living and Pleistocene shells from the east coast of Colombia available for comparison, it does not seem that there are specific differences between them and the California fossils, but the problem must remain open until living specimens from the west coast can be obtained.

The status of the fossil species, *V. haitensis* (Sowerby),⁴⁶

⁴² Bull. Mus. Comp. Zool., Vol. 43, 1908, No. 6, p. 327, pl. 11, fig. 14.

⁴³ Maz. Cat., p. 456, 1857.

⁴⁴ Proc. U. S. Nat. Mus., Vol. 37, 1910, p. 211.

⁴⁵ Man. Conch., Vol. 4, 1882, p. 71.

⁴⁶ Quart. Journ. Geol. Soc. London, Vol. 6, 1849, p. 50. Vol. 32, 1876, p. 523, pl. 29, fig. 3.

and *V. h. engonatum* Dall,⁴⁷ from the Florida and West Indian Tertiary deposits, has not been investigated in this connection. Maury⁴⁸ considered the two very close but did not pass upon the near identity of the fossils with living shells.

33. *Vermicularia eburnea* Reeve

This is the only member of the family Vermetidæ which has been found in the Imperial County deposits. Six specimens have come from locality 682 (C.A.S.). Some of them are fairly well preserved and agree with specimens found living at San Diego, California, and in the Gulf.

PELECYPODA

34. *Anomia subcostata* Conrad

Plate 23, figures 3, 4, 5

Specimens examined

Locality	Collection	Number
51	U.C.	19
55	U.C.	2
3919	U.S.G.S.	4
3922	U.S.G.S.	6
6836	U.S.G.S.	3
684	C.A.S.	39
687	C.A.S.	9
690	C.A.S.	11
701	C.A.S.	7

Among this large number there is exhibited great variation in shape, sculpture and weight. The radial sculpture ranges from very decided ribs to none at all and a separation into two species with this character as a basis would be valueless.

The name given above is used because Conrad's type came from Carrizo Creek, and he described and figured the shell so that it can be recognized, but it is quite possible that these fossils are not separable from some of the recent species which have earlier names.

⁴⁷ Trans. Wag. Free Inst. Sci., Vol. 3, pt. 1, 1890, p. 100.

⁴⁸ Bull. Am. Pal. No. 29, 1917, p. 84.

ARCIDÆ

Most collectors have obtained numerous specimens of arcas in the Coyote Mountain deposits and vicinity, but the preservation has been so poor that specific identification cannot well be attempted. Most of these have been casts; in the few cases where the shell substance is preserved, it is so badly crystallized that external sculpture is largely obliterated.

35. *Atrina stephensi* Hanna, new species

Plate 27, figures 3, 4

Shell robust, inflated, beaks acutely pointed; both margins concave toward beaks; growth ridges rough but not scaled or spinose; radial ridges on posterior two-thirds of shell; these are wavy in cross section, but not spinose; byssal area flat, the opening 3.5 mm. wide; valves gape broadly. Length 200 mm.; thickness, 60 mm.; width, 112 mm.

Type: Preserved in the Museum of the San Diego Society of Natural History; *plastotype*, No. 1816, Calif. Acad. Sci. from **Coyote Mountain, Imperial County, California**; Chas. H. Sternberg, coll.

This species appears to be more closely related to *A. oldroydi* than any other; comparison has been made with the type of that species in Stanford University and it is found to have a convex swelling on the ventral margin; the radial ridges do not extend on the ventral half of the shell and the byssal area is not so flattened.

The type only has been collected; but numerous specimens of what appeared to be the same were seen by the writer embedded in an overhanging cliff on the north side of Coyote Mountain where they could not be reached.

This species is named for Mr. Frank Stephens, veteran naturalist and collector of San Diego, Calif.

36. *Barnea costata* Linnæus

Plate 28, figures 5, 6

Specimens examined

Locality	Collection	Number
701	C.A.S.	2
51	U.C.	5
6847 (324575 U.S.N.M.)	U.S.G.S.	1

The specimen figured is 58.5 mm. long and 20.7 mm. high. The others are but little if any larger. All are internal casts and well preserved, but dorsal plates are lacking. Regarding the identification of the specimens with the common east coast species, it should be said that they correspond exactly in shape, number of ribs and form of sculpturing on the inside of the shells. The species is found living on the east coast from Massachusetts south to Brazil and fossils date back to the Pliocene according to Dall.⁴⁹ The Miocene species of the east coast differs little from it. The use of the generic name *Barnea* Risso, instead of *Pholas* Linnæus, is in accordance with the definition of the genus as given by Dall.

In addition to some peculiar borings found in the coral heads in Alverson Cañon, Coyote Mountain, the California Academy of Sciences' Collection (Loc. 701) contains four specimens which are distinctly the work of *Lithophaga* or *Pholadidea*. The holes have been made in massive marble, subsequently filled with fine sediment and solidified. No remnants of the shells remain. They came from the collection of the California State Mining Bureau and may represent some such specimens as those photographed by Merrill^{49a} and published in 1914.

CARDIIDÆ

The various collections contain numerous casts of at least three species of the genus *Cardium*. They resemble, in shape, living species of the Gulf of California, but without external sculpture positive identification would not be safe.

⁴⁹ Trans. Wag. Free Inst. Sci., Vol. 3, pt. 4, 1898, p. 816.

^{49a} Merrill, F. I. H. Mineral Resources of San Diego and Imperial Counties [California]. Calif. St. Min. Bur. 14th Ann. Rept., for 1913-1914 [1916], p. 735; advance copy Dec. 1914.

37. *Chama frondosa* Broderip

In the coral reef of Alverson Cañon, locality 681 (Calif. Acad. Sci.) 13 specimens of this species were secured. The maximum size is about 70 mm. by 50 mm. which is considered small. Exteriorly the shell substance has been greatly bored by other organisms and incrustated with bryozoa and worms. The limestone matrix adheres very tenaciously to both the inside and outside of the shells. The species has been recorded in the Gulf of California as far north as Guaymas,⁵⁰ and Dall⁵¹ gives its range as extending from San Diego, California, to Peru.

38. *Codakia colpoica* Dall*Specimens examined*

Locality	Collection	Number
3922	U.S.G.S.	3
6847	U.S.G.S.	3
680	C.A.S.	2
682	C.A.S.	6

All of the above are more or less imperfect and the valves are firmly united so that the hinges cannot be seen. In shape and sculpture they agree perfectly with specimens from the Gulf of California.

This is the species which was formerly called *C. tigrina* by Carpenter and others. Dall,⁵² however, pointed out the differences between the west and east coast forms in his "Synopsis of the Lucinacea" and described the one from the Gulf of California as new.

39. *Crassitellites subgibbosus* Hanna, new species

Plate 28, figures 1, 2, 3, 4

Shell similar to *C. gibbosus* Sowerby but less swollen, and in specimens of the same size, the posterior end is longer and less up-turned. Surface roughened by growth ridges of unequal strength; umbones with three heavy undulations; hinge area and teeth similar to *gibbosus* as figured by Nelson⁵³ except

⁵⁰ Carpenter, Catalog Mazatlan Shells, 1857, p. 89.

⁵¹ Bull. 112, U. S. Nat. Mus., 1912, p. 33.

⁵² Proc. U. S. Nat. Mus., Vol. 23, 1901, p. 821, pl. 41, fig. 4.

⁵³ Trans. Conn. Acad. Arts and Sci., Vol. 2, pt. 1, 1870, p. 203, pl. 7, fig. 9.



that the central cardinal of the right valve of our species has a side brace, or spur projecting into the resilium; also in *subgibbosus* there does not appear to be the crenulation between the first and second cardinals of the right valve which he showed. Length, 55 mm.; height, 41 mm.; thickness, 29 mm. (Type.)

Type: No. 1818, Mus. Calif. Acad. Sci., from Loc. 682, **Coyote Mountain, Imperial County, California**; G. D. Hanna, coll. *Paratype*: In Univ. Calif. Coll. from Loc. 738 (U. C.). Cast of same, No. 1819, Calif. Acad. Sci.

"*Crassitella gibbosa*" was described by Sowerby⁵⁴ from Middle America and illustrated by Reeve.⁵⁵ Its range is given by Dall⁵⁶ as extending from the Gulf of California to Paita, Peru. While no specimens of the species have been available for comparison, no fossils from Imperial County have been found which agree with the two figures to which reference has been made. Reeve's figure shows a specimen with a slightly up-turned posterior extremity and the ventral margin has a compound curve toward that end. Our specimens do not appear to have such a curve. The ventral margin of *gibbosus* appears much more convex than *subgibbosus*.

Comparison need hardly be made with the fossil species of Panama, Costa Rica and the Isthmus of Darien, *C. reevei* Gabb and *C. mediamericanus* Brown and Pilsbry. Both of them have regular ribbing on the surface, concentric with the growth lines.

The material available has been 10 specimens from locality 738 (U.C.), two from locality 3923 (U.S.G.S.) and 13 from locality 682 (C.A.S.).

40. *Divaricella eburnea* Reeve

Plate 26, figures 8, 9

Specimens examined

Locality	Collection	Number
738	U.C.	10
682	C.A.S.	8
6847	U.S.G.S.	4

⁵⁴ Proc. Zool. Soc., Vol. 2, 1832, p. 56.

⁵⁵ Con. Icon. Crassitella, 1843, pl. 1, fig 1.

⁵⁶ Proc. U. S. Nat. Mus., Vol. 37, 1910, p. 260.

Except for the slightly coarser sculpture, these specimens do not differ from some from the Galapagos Islands; others found in the Pleistocene deposits at Magdalena Bay, Lower California, appear identical; the same is true of many shells from the Gulf of California. Preservation of the Coyote Mountain fossils is not good and the valves are associated so firmly that hinges could not be examined.

41. *Dosinia dunkeri* Philippi

Specimens examined

Locality	Collection	Number
738	U.C.	12
682	C.A.S.	1
3919	U.S.G.S.	2
3923	U.S.G.S.	1

The best preserved of the above specimens is figured. It measures: length 68.2 mm.; height, 71 mm.; thickness (one valve) 18.1 mm. The state of preservation is such that they cannot be satisfactorily separated from *dunkeri*, a species found living from Panama north to the head of the Gulf of California.

42. *Echinochama californica* Dall

Echinochama californica, DALL, Trans. Wagner Free Inst. Sci., Vol. 3, pt. 4, 1903, p. 1404.

Specimens examined

Locality	Collection	Number
682	C.A.S.	1
3923	U.S.G.S.	2

The above specimens from Coyote Mountain are not perfectly preserved but there is little doubt that they belong to the species *californica*, from Lower California.

The east American analogues are *E. arcinella* Linnæus, a living form, and *E. antiquata* Dall from various fossil horizons dating back to the Miocene. All form a group of closely related species, the separation of which has not been very satisfactory.

43. *Glycymeris gigantea* Reeve

Of this large species there are five specimens from Loc. 738 (U.C.) collected by W. S. W. Kew. No other collector seems to have met with it in that region. Comparison has been made with living specimens from the Gulf of California as well as with Reeve's description and figure and no differences of apparent consequence could be detected.

44. *Cyathodonta undulata* Conrad

<i>Specimens examined</i>		
Locality	Collection	Number
4	U.C.	1
681	C.A.S.	1
3923	U.S.G.S.	1

These are casts and are somewhat smaller and thinner than living specimens from San Diego, California, supposed to be *C. dubiosa* Dall,⁵⁷ an unfigured species. In describing *C. undulata*, Conrad^{57a} gave no definite locality, but Dr. Dall has stated that it is found at Lapaz and other places in the Gulf of California.

45. *Lucina edentuloides* Verrill

Lucina edentuloides VERRILL, DALL, Proc. U. S. Nat. Mus., Vol. 23, 1901, p. 802.

<i>Specimens examined</i>		
Locality	Collection	Number
738	U.C.	1
680	C.A.S.	1
681	C.A.S.	5
683	C.A.S.	4
701	C.A.S.	25
6847	U.S.G.S.	3

Of this species there are numerous specimens in the various collections, all of which, it appears, were collected from a hill slope on the west side of Alverson Cañon, Coyote Mountain. At a point where the coral reef crosses the stream bed these shells are weathered out and can be had in considerable num-

⁵⁷ Proc. U. S. Nat. Mus., Vol. 49, 1916, p. 445.

^{57a} Proc. Acad. Nat. Sci. Phila., Vol. 4, 1849, p. 155.

bers. In every case seen they were crystallized and the valves were fastened together so that the hinge structure could not be ascertained. The shape, however, coincides with that of living specimens found from Magdalena Bay, Lower California, southward. The beaks of this species are more centrally placed than in the one of the West Indies.

46. *Metis excavata* Sowerby

Plate 23, figure 6

One specimen in an excellent state of preservation was secured by Kew and English at locality 738 (Univ. Calif.). It is 47.5 mm. from the beak to the ventral margin and does not differ in any noticeable character from specimens found in the Gulf of California living at the present time.

47. *Ostrea heermanni* Conrad

Plate 22, figures 7, 8; plate 23, figures 1, 2

Ostrea heermanni CONRAD, Proc. Acad. Nat. Sci. Phila., 1855, p. 267—
CONRAD, House Ex. Doc. 129, 33rd Cong. 1st Sess., 1855, p. 15—
CONRAD, Pac. R. R. Repts., Vol. 5, 1857, p. 325.

"Very irregular in form, thick, ovate and often dilated; lower valve shallow; exterior very irregular, with large distant angular radiating ribs and with pits, irregular cavities; cartilage pit broad and oblique; upper valve flat or concave, with a profoundly irregular surface. Length, 5.75 inches; height, 6.5 inches." (Original description.)

Although this species has not been previously figured, so far as I have been able to determine, there is no mistaking the fact that Conrad had specimens of the only large circular oyster of the Coyote Mountain region. It is excessively abundant in many places and also excessively variable. Uneroded specimens, however, show clearly that it is an irregularly ribbed species. The two specimens figured herewith show the characters well. Blake stated in a footnote to Conrad's description that although Dr. Heermann picked up the original specimens from the bed of Carrizo Creek, there was no doubt but that they came from the formation near at hand. I saw some examples in the cliffs of Alverson Cañon that were fully a foot in diameter.

48. *Ostrea iridescens* Gray

Plate 26, figures 4, 5, 6, 7

There are a few scattered beds of this fine species about Coyote Mountain where the shells occur in characteristic abundance on the surface. At localities 689 and 692 (C.A.S.) there were secured four and 15 respectively. These do not differ from recent specimens of the Gulf of California which are characterized by the arrangement of the shell substance in comparatively flat and regular layers. *O. chilensis* Philippi, the western representative of *O. virginica* Gmelin according to Dall,⁵⁹ has the layers irregular and often somewhat crenulated. *O. iridescens* was first adequately described by Carpenter in 1857.⁶⁰

49. *Ostrea vespertina* Conrad

Plate 26, figures 1, 2, 3

Specimens examined

Locality	Collection	Number
3919	U.S.G.S.	2
3921	U.S.G.S.	12
3922	U.S.G.S.	7
3923	U.S.G.S.	4
6836	U.S.G.S.	5
6847	U.S.G.S.	1 (=324, 601 U.S.N.M.)
324602	U.S.N.M.	1
738	U.C.	6 (=55 W.S.W.Kew)
....	U.C.	8 (=51 W.S.W.Kew)
....	U.C.	1 (=53 W.S.W.Kew)
3003	U.C.	2
Unnumbered		8
681	C.A.S.	5
682	C.A.S.	3
683	C.A.S.	15
684	C.A.S.	11
690	C.A.S.	3
691	C.A.S.	5
694	C.A.S.	2
701	C.A.S.	6

⁵⁹ Nautilus, Vol. 28, p. 3, 1914.⁶⁰ Cat. Mazatlan Shells, 1857, p. 157.

When the above list was made out, it was believed to be best to unite all the plicate oysters of the Coyote Mountain region under one name. Sufficient comparative material was lacking for a logical separation of species. Therefore the collections listed from the U. S. Geological Survey and the University of California contain some specimens of *O. heermanni* as well as *O. vespertina*.

Since the list was made and the collections returned, a large amount of comparative material, living and fossil from the Gulf of California region has been obtained, and it is believed that a separation into two species can be made with reasonable certainty, the large one taking the name *O. heermanni*.

Ostrea vespertina was first described from San Diego (Conrad, Journ. Phila. Acad. Sci.) in 1853, but was not figured until Conrad considered the specimens obtained by Blake from the Colorado desert where Carrizo Creek flows out of the Laguna Mountains upon the valley floor. Subsequent collecting at San Diego by many experienced workers has resulted in obtaining but one plicate oyster and that is the one described by Gabb⁶¹ from Cedros Island as *O. veatchii*. That the latter is synonymous with *vespertina* can scarcely be questioned. The identity was pointed out by Dall in 1898⁶² and concurred in by Arnold in 1909.⁶³ The former considered both names as well as *O. heermanni* Conrad, the equivalent of *O. haitensis* Sowerby, 1850, an east American species. The later views of Dall regarding the living species of western oysters are set forth in a little paper published in 1914.⁶⁴ Here we find *O. veatchii* given the status of a species.

Whether the Carrizo Creek and Coyote Mountain oysters called *vespertina* are the same as San Diego specimens originally given that name cannot be stated with certainty, but seems probable. Around the flanks of Coyote Mountain the shells form great reefs, thoroughly consolidated and cemented, in some places already partially converted to marble. Such metamorphism is unusual for such late deposits in western North America.

⁶¹ Geol. Surv. Calif. Pal., Vol. 2, 1869, p. 35, pl. 11, fig. 61.

⁶² Trans. Wagner Free Inst. Sci., Vol. 3, pt. 4, 1898, p. 686.

⁶³ U. S. Geol. Surv. Bull. 396, 1909, p. 78.

⁶⁴ Nautilus, Vol. 28, 1914, p. 3.

50. *Panope generosa* Gould*Specimens examined*

Locality	Collection	Number
738	U.C.	4
3923	U.S.G.S.	1
682	C.A.S.	1
688	C.A.S.	1
701	C.A.S.	2

As usual with this species, a considerable amount of variation is shown in the series. The specimen from Locality 3923 (U.S.G.S.) is particularly attenuated anteriorly, but not more so than some living shells.

51. *Pecten carrizoensis* Arnold

Pecten carrizoensis ARNOLD, U. S. Geol. Surv. Prof. Pap. 47, 1906, p. 59, pl. 4, figs. 1, 1a, 1b, 2, 3, 3a.

Specimens examined

Locality	Collection	Number
3922	U.S.G.S.	1
6847	U.S.G.S.	2 (Numbered 324, 575, U.S.N.M.)
738	U.C.	9
680	C.A.S.	6
682	C.A.S.	7

The original specimens of this species came from the vicinity of Coyote Mountain and the most perfect among the above is a juvenile 31.8 mm. in diameter. *P. stearnsii* Dall, *P. diegensis* Dall and this species form a group of flat sided pectens which are much alike. *P. stearnsii* has the greatest number of ribs and each one is divided by a longitudinal sulcus. *P. carrizoensis* has the least number of ribs (about 20) and they are more rounded (less square) than in either of the other species.

52. *Pecten deserti* Conrad

Plate 25, figures 1, 2, 3

This species was originally described from specimens collected in the region by Blake and, being common, is very well known. The various collections studied have contained a great

many specimens of it. The species is most common in the hard "oyster reefs" of the uppermost beds exposed. Some places these beds are consolidated into firm rock; again they have disintegrated and the desert floor then becomes carpeted with the shells of *Pecten deserti*, *Ostrea vespertina* and *Anomia subcostata*. They thus become scattered far and wide.

53. *Pecten keepi* Arnold

Specimens examined

Locality	Collection	Number
3922	U.S.G.S.	2
3923	U.S.G.S.	2
6847	U.S.G.S.	4
324, 562	U.S.N.M.	1
738	U.C.	3
739	U.C.	2
680	C.A.S.	7
681	C.A.S.	7
682	C.A.S.	2
683	C.A.S.	1
687	C.A.S.	1
688	C.A.S.	1
701	C.A.S.	4

The species was described from these deposits and seems to have no close living relative on the Pacific coast, but belongs with *P. ziczag* Linnæus of the West Indies and *P. murtoni* Ravenel⁶⁵ of various east coast fossil deposits.

It is one of the most common species in the Coyote Mountain region. Specimens were seen in the black limestone which caps a southern slope of the mountain east of Alverson Cañon where the matrix was so hard that the shells could not be extracted, and the stone rang like tempered steel when struck with a hammer. No specimens were seen higher up in the sequence of strata than that, but from there downward to the basal exposure (the coral reef in Alverson Cañon) the shells were everywhere in evidence.

⁶⁵ Böse, Inst. Geol. Mex. Bull. 22, p. 24, pl. 1, figs. 3, 6, 9, pl. 8, pl. 9, fig. 3.

54. ***Pecten mediacostatus*** Hanna, new species

Plate 22, figure 6; plate 24, figure 2

Shell small, altitude a little greater than length, equilateral and equivalve, not noticeably inflated. Surface sculptured with 23 (in the type specimen) ribs which are regularly rounded and are largest in the center of the valve. These ribs are strong at the ventral margin of the shell but are scarcely visible within 18 mm. of the beak; interspaces occupied by riblets, one to each, about one-third the size of the major ribs; in the better preserved specimens there is a fine even concentric sculpture of lirulæ looped over the ribs, appearing as though cut with an engraving tool; anterior ear marked with five (in cotype) radiating riblets while the posterior (in the type) is smooth except for fine even concentric sculpture. Measurements of type specimen, a single right valve, altitude 37.2 mm.; length 30 mm. (slightly compressed longitudinally); thickness 8.5 mm.

Type: No. 1830, Mus. Calif. Acad. Sci. from Loc. 681 (C. A. S.) **Alverson Cañon on the south side of Coyote Mountain, Imperial County, California**, in the Pliocene coral reef about midway up the cañon.

There is only one west coast species with which the sculpture of this can be compared, *Pecten estrellanus* (Conrad) of Miocene and lower Pliocene strata. That species is more inflated, longer than high, and the ribs extend entirely to the beak; moreover, the ribs are squarish and interspaces channelled on each side of the smaller riblet.

Twenty-seven specimens were obtained from the coral reef of Alverson Cañon, Loc. 681, and one from Loc. 683, both of the California Academy of Sciences' series. The reef is a well-marked feature of the topography as one ascends the cañon, yet it does not appear to have been explored heretofore, since none of the numerous collections seen has contained this species. Like *P. sancto-ludovici* the specimens are more or less poorly preserved and usually somewhat crushed out of shape.

55. *Pecten mendenhalli* Arnold

Plate 25, figures 4, 5

Specimens examined

Locality	Collection	Number
3922	U.S.G.S.	4
3923	U.S.G.S.	13
324, 549	U.S.N.M.	1
738	U.C.	10
2064	U.C.	7
681	C.A.S.	1
701	C.A.S.	2

Shape and sculpture are as Arnold⁶⁶ has described. Each ear is consistently heavily sculptured with several ribs, but these are shown as smooth in *P. cerrosensis* Gabb.⁶⁷ The species, *circularis*, *deserti*, and *mendenhalli* are undoubtedly very closely related. With a large series of specimens from different places, it is possible all would be found to constitute an intergrading series, but at present some of the connecting links seem to be absent.

56. *Pecten sancti-ludovici* Anderson and Martin

Plate 22, figures 1, 2, 3

This species was described⁶⁸ from material collected "along the west side of San Juan River about one-half mile above the mouth of Navajoa Creek, Northeastern San Luis Obispo County, California," by Bruce Martin. Other specimens were taken in the near vicinity. All came from strata of the "Santa Margarita" formation or Upper Miocene. The type, a paratype, and six other specimens from the type locality, are in the California Academy of Sciences and all are beautifully preserved.

Until now the species does not appear to have been found elsewhere, but in the coral reef of Alverson Cañon, Imperial County, California, Loc. 681 (C.A.S.) 12 specimens were taken. Two additional specimens were taken at Loc. 683 (C.A.S.) and there is a crushed one from Loc. 2064 (U.C.). All are somewhat broken and crushed, but they are placed

⁶⁶ U. S. Geol. Surv. Prof. Pap. 47, 1906, p. 84, pl. 25, figs. 2, 2a, 2b.

⁶⁷ Geol. Surv. Calif. Pal., Vol. 2, 1869, pl. 9, fig. 55.

⁶⁸ Proc. Calif. Acad. Sci. 4th ser., Vol. 4, 1914, p. 55, pl. 3, figs. 10a, 10b.

with the Santa Margarita form without hesitation. Rarely are examples of any species from two localities so nearly identical.

The sculpture of the species at once recalls *hastatus* and if only the right valve were known, it could be easily taken for that. The number of ribs is about the same, likewise the serrations of the riblets; but there is no tendency in *sancti-ludovici* for the ribs to be double or in pairs. The main distinguishing feature, however, is the fact that while the left valve only of *hastatus* has about nine ribs, in *sancto-ludovici* the number is the same as in the right.

57. *Pecten subnodosus* Sowerby

Plate 25, figure 6

Specimens examined

Locality	Collection	Number
738	U.C.	6
680	C.A.S.	1
690	C.A.S.	4

These specimens are not perfectly preserved, but with a large series of living and fossil shells from the Gulf of California region for comparison, there is believed to be no adequate reason to doubt the identity. None of the above specimens had so many riblets between the main ribs as have been seen in some living shells, but this is probably due to the small series; certainly some living individuals, unquestionably *subnodosus*, have as few riblets as these. As in *P. ethegoini* farther north, the strength of the nodes varies greatly in a series of shells.

58. *Phacoides xantusi* Dall

Plate 28, figure 7; plate 29, figure 1

Phacoides xantusi DALL, Nautilus, Vol. 18, 1903, p. 110.

Phacoides childreni of authors; not of Gray.

Specimens examined

Locality	Collection	Number
738	U.C.	3
2064	U.C.	1
3923	U.S.G.S.	3
681	C.A.S.	17

The above specimens are all more or less crystallized so that the finer sculpture is obliterated, and the valves are so firmly fastened together that the hinge structure has not been examined. This and four other species, one of the Miocene and Pliocene of California,⁶⁹ one of the east American recent fauna,⁷⁰ one east American Pliocene form,⁷¹ and one of the Florida Miocene,⁷² form a group of closely related forms. The Coyote Mountain fossils, however, seem to be most closely related to the shells found living in the Gulf of California at the present time. It has already been listed as *P. childreni* from the Pliocene of Lower California at San Juan by Dall (Op. cit. 1903).

59. *Pinna latrania* Hanna, new species

Plate 27, figure 1; text figure 1

Shell thin, long and slender, apical angle acute (27°); surface apparently unmarked externally by ridges, ribs or spines, except for a heavy longitudinal mid-rib in each valve; this is

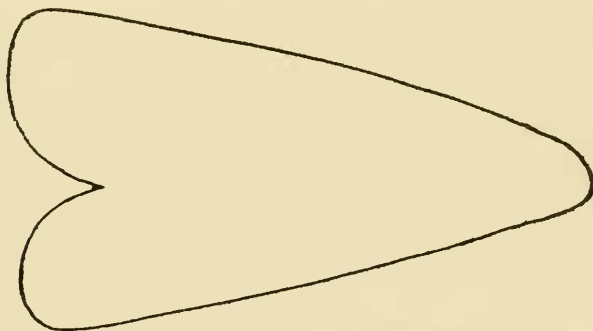


Fig. 1. Outline of *Pinna latrania*, n. sp.

rounded convex, internally and apparently sharply carinate externally and divided longitudinally, the two parts being united by cartilage; the length of this rib is unobtainable from available material, but in other species it does not extend entirely to the beak; each valve is deeply sulcate at the mid-rib

⁶⁹ *P. sanctæcrucis* Arnold, U. S. Geol. Surv. Bull. 396, 1909, p. 57, pl. 6, fig. 6.

⁷⁰ *P. childreni* Gray.

⁷¹ *P. smithwoodwardi* Maury, Bull. 29, Am. Paleo., 1917, p. 204, pl. 35, fig. 6.

⁷² *P. caloosensis* Dall Trans. Wagner Free Inst. Sci., Vol. 3, pt. 6, 1903, pl. 28, fig. 1.

so that in looking down upon it, it is double-looped. Length of type specimen, 135 mm.; width from hinge line down, 63 mm.; gape posteriorly, 51 mm.; length of hinge line, 116 mm.; length of byssal scar, 85 mm.

Type: No. 324,593 (U. S. Nat. Mus.) from Loc. 3922 (U. S. Geol. Surv.), **Coyote Mountain, Imperial County, California**. A cast of the type is No. 1837 (C. A. S. Coll.).

The type specimen lacks both anterior and posterior ends and is largely a decorticated cast. A paratype in the Museum of the San Diego Society of Natural History was collected at the same locality by Mr. Frank Stephens. This specimen shows the shape of the posterior end of the shell. A cast of it is preserved as No. 1838 of the California Academy of Sciences.

60. *Pinna mendenhalli*, Hanna, new species

Plate 27, figure 2

Shell thick and heavy; apical angle obtuse (47°); outer surface without sculpture or distinct ribs; there is a low longitudinal ridge, however, on the ventral half of each valve; mid-rib exceedingly heavy (7 mm. thick in a fragment preserved on one specimen); rounded on the interior and apparently sharply carinate on the exterior. Each valve appears to be divided through this rib for at least a portion of its length because in the remnants of the shell preserved on the casts, there are ligament scars as shown in the figure. The gape extends the full length of the shell and the byssal scar appears to do the same; beak and posterior margins not seen. Greatest length of type, 167 mm.; greatest breadth, 98 mm.; thickness, 58 mm.; full dimensions were: length about 200 mm. and breadth 100 mm.; thickness of the paratype is 66 mm.

Type: No. 324,593 (U. S. Nat. Mus.) from locality 3922, (U. S. Geol. Surv.). One paratype from the same place bears the same number. Both specimens are imperfect and little better than internal casts. A cast of the type is preserved as No. 1839 (C.A.S. Coll.).

This species is unlike any other from west coast Tertiary and appears to resemble *P. caloosensis* Dall⁷³ from the Florida

⁷³ Ter. Faun. Fla., Vol. 3, pt. 4, 1898, p. 660, pl. 26, fig. 4.

Pliocene in a general way. The resemblance, however, is only in structure and not in form because that species has an apical angle of only about 18° . It is closer to *P. latrania*, new species, from the Imperial County deposits than any other known to the writer.

The species is named for Mr. W. C. Mendenhall, who, with Dr. Stephen Bowers, collected the type material and who very kindly gave me much information relative to the occurrence of fossils.

61. *Spondylus calcifer* Carpenter

In the collections of fossils from Coyote Mountain, there are several specimens which do not appear to differ from this living species of the Gulf of California. Two are from Loc. 3923 (U.S.G.S.); one from Loc. 53 (2064) (U.C.); and one from locality 685 (C.A.S.). Not any of these, however, has reached the ponderous size which is attained by some living examples of the species. Consequently they have been compared with the young of *calcifer*. All are more or less imperfect. The best is from the first locality mentioned and it has been figured. It is seen to be very irregularly spinose; concentric sculpture is almost absent; the beak is very high and the ligamentary canal continuous to the apex.

I have seen 12 names which have been applied to west coast Spondylidæ, and there may be others. Most of these, however, have been applied to various and sundry modifications of the forms known as *pictorum* and *limbatus*, no representatives of which appear in the fossil beds at the head of the Gulf.

62. *Spondylus bostrychites* Guppy

Plate 24, figures 3, 4

Spondylus bostrychites GUPPY, Proc. Sci. Soc. Trinidad, p. 176, 1867—GABB, Geol. Santo Domingo, 1873, p. 257—DALL, Tert. Faun. Fla., Vol. 3, pt. 4, 1898, p. 758—DALL, Bull. 90, U. S. Nat. Mus., 1915, p. 124, pl. 19, fig. 4—MAURY, Bull. 29, Am. Paleo., 1917, p. 190, pl. 32, fig. 4.

This species, first described as *S. bifrons* in 1849,⁷⁴ was not figured until 1915, and then very imperfectly. No one has

⁷⁴ Sowerby, Quart. Jour. Geol. Soc. Lond., Vol. 6, 1849, p. 53.

shown the hinge area although Sowerby stated in his original description that it is "easily distinguishable by the area of one valve being very narrow and that of the other valve being rather broader, though still narrow." Both Gabb's and Guppy's mention of the species *bostrychites* are in publications which are very inaccessible and no one has thus far given a description of the species, since those authors wrote. Identification would have probably been impossible had it not been for the fact that our specimens were compared directly with Guppy's type of *bostrychites* and other material in the National Museum. This was done through the kindness of Mr. W. C. Mansfield.

Guppy's type was a young individual similar to the one Maury has figured. Dall's figure is of an older example, but neither of them shows the minute sculpture which appears to be characteristic; at any rate, it is present on the type and others.

At Loc. 738 (U.C.) and also at Loc. 685 (C.A.S.) a specimen was secured. The former is the more perfect and has been figured. The spines are arranged in five radial rows, but they have been broken away so that their length cannot be compared with those of *bostrychites*. In the intervening spaces, there are from five to nine smaller radial ridges which become slightly spinose toward the outer margin of the shell. These are irregular in size. The surface is marked by very small, wavy, concentric lines which are broken into many papillæ, particularly toward the center of the shell. The hinge area is slightly heavier than in the specimens from Santo Domingo which were compared, but this is a variable character in the genus. The ligamentary groove extends to the apex. Apex not elevated or spiral. Valves of about equal size and convexity. In the latter respect the species differs from *S. scotti* Brown & Pilsbry⁷⁵ and the larger species which they did not figure and therefore cannot be recognized.

The specimen figured, although somewhat broken, measures 86 mm. in a line parallel to the hinge, and 99 mm. high. The larger specimen measures 115 mm. by 125 mm. but it likewise is imperfect. If perfect, the latter dimension would be increased by about 10 mm.

⁷⁵ Proc. Acad. Nat. Sci. Phila., 1912, p. 514, pl. 25, figs. 1, 2.

63. *Tagelus californianus* Conrad

A single specimen of *Tagelus* was obtained at Loc. 6847 (U.S.G.S.). It does not differ from specimens of the above species which is exceedingly common in the Gulf of California. It measures: length, 55 mm.; height in center, 22.3 mm.; thickness as preserved, 13.5 mm.

ECHINODERMATA

64. *Clypeaster bowersi* Weaver*Specimens examined*

Locality	Collection	Number
680	C.A.S.	2
682	C.A.S.	1
701	C.A.S.	2
3919	U.S.G.S.	1
3922	U.S.G.S.	2
3923	U.S.G.S.	2

This huge species was described from deposits on Coyote Mountain, and there it is very abundant. The writer does not feel competent to pass judgment upon its validity, but with probably better living material from the Gulf of California available for comparison than has heretofore been gathered together in a western museum, it seems exceedingly doubtful if the fossils are really distinct.

65. *Clypeaster deserti* Kew*Specimens examined*

Locality	Collection	Number
680	C.A.S.	2
3919	U.S.G.S.	1

No living species comparable to this was collected in the Gulf of California in 1921 by the Academy and it is not known if there be one there.

66. *Encope tenuis* Kew*Specimens examined*

Locality	Collection	Number
680	C.A.S.	6
3919	U.S.G.S.	2
3922	U.S.G.S.	2



67. *Hippnoë californica* Kew

One well-preserved specimen from Loc. 3922 (U.S.G.S.) is somewhat crushed, but it is the best preserved representative of the species in existence so far as the writer knows. It certainly is better than the one which Kew used for a type and which also came from Coyote Mountain deposits.

68. *Metalia spatagus* (?) Linnæus

Plate 24, figure 1

Metalia maculosa AGASSIZ, Mem. Mus. Comp. Zool., Vol. 3, 1872, pp. 144, 598, pls. 21b, 26, 38.

Metalia spatagus LINNÆUS, CLARK, Mem. Mus. Comp. Zool., Vol. 46, No. 2, p. 210.

This identification of the single specimen of spatangoid echinoderm from locality 3919 (U. S. Geol. Surv.) is attended with some doubt because of poor preservation. The specimen is small; length, 32 mm.; width, 25 mm.; height, 15.6 mm. It is so eroded that none of the markings or plates remains but resembles in shape some specimens of *Metalia spatangus* from the Gulf of California. The lateral petals of the fossil are somewhat decumbent and may be the mark of a new species, but the writer is not sufficiently acquainted with the group to venture a description on such fragmentary material. Kew has recorded no species of the group from Coyote Mountain and apparently this is the first and only specimen that has been found there. One would naturally expect such forms as *Meoma grandis*, but thus far they have not been found.

CORALS

The coral fauna of the Coyote Mountain district is exceedingly interesting and has been thoroughly studied by Dr. T. W. Vaughan. No less than 12 named forms are found in the various reefs. The locality is remarkable in being the northernmost representation of the groups in west American Tertiary, Quaternary, or Recent faunas. At the present time, reef building corals are not abundant on the west coast north of

the Tres Marias Islands, although this scarcity may, in part, be due to imperfect exploration about the islands of the Gulf of California. Some fine specimens, stated to have come from there were on display at the interstate exhibition held in Mazatlan, Sonora, in 1925.

69. *Dichocœnia merriami* (Vaughan)

Favia merriami VAUGHAN, U. S. Geol. Surv. Monog. 39, 1900, p. 142, pl. 15, figs. 5, 5a-c.—NOMLAND, Univ. Calif. Publ. Geol., Vol. 9, 1916, p. 60.

Dichocœnia merriami VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 370, pl. 94, figs. 1, 1a.

70. *Dichocœnia merriami crassisepta* Vaughan

Dichocœnia merriami crassisepta VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 371, pl. 94, figs. 3, 3a.

71. *Eusmilia solida* (Nomland)

Madripora solida NOMLAND, Univ. Calif. Publ. Geol., Vol. 9, 1916, p. 60.

Eusmilia carrizensis VAUGHAN, U. S. Geol. Surv. Prof. Ppr. No. 98, 1917, p. 369, pl. 95, figs. 1, 1a.

Dr. T. W. Vaughan told me on January 18, 1922, his species should be referred to the name selected by Mr. Nomland.

72. *Mæandra bowersi* (Vaughan)

Diploria bowersi VAUGHAN [nomen nudum] U. S. Geol. Surv. Prof. Ppr. 47, 1906, p. 22.

Mæandra bowersi VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 374, pl. 101, figs. 1, 1a.

73. *Porites carrizensis* Vaughan

Porites carrizensis VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 375, pl. 102, figs. 5, 5a, 5b, 6, 6a.

74. *Siderastrea californica* Vaughan

Siderastrea californica VAUGHAN [nomen nudum] U. S. Geol. Surv. Prof. Ppr. 47, 1906, p. 22.—VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 375, pl. 102, figs. 2, 2a, 3, 4.

75. *Siderastrea mendenhalli* Vaughan

Siderastrea mendenhalli VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 374, pl. 101, figs. 3, 3a, 4.

76. *Siderastrea mendenhalli minor* Vaughan

Siderastrea mendenhalli minor VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 375, pl. 102, fig. 1.

77. *Solenastrea fairbanksi* (Vaughan)

Stephanocania fairbanksi VAUGHAN, U. S. Geol. Surv. Monog. 39, 1900, p. 151, pl. 17, figs. 11, 11a.—VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 47, 1906, p. 22.—NOMLAND, Univ. Calif. Publ. Geol., Vol. 9, 1916, p. 60.

Plesiastrea californica VAUGHAN [nomen nudum], U. S. Geol. Surv. Prof. Ppr. 47, 1906, p. 22.

Solenastrea fairbanksi VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 372, pl. 95, figs. 3, 3a.

78. *Solenastrea fairbanksi columnaris* (Vaughan)

Stephanocania fairbanksi columnaris VAUGHAN, U. S. Geol. Surv. Monog. 39, 1900, p. 151, pl. 17, figs. 10, 10a.—VAUGHAN, U. S. Geol. Survey, Prof. Ppr. 47, 1906, p. 22.—NOMLAND Univ. Calif. Publ. Geol., Vol. 9, 1916, p. 60.

Solenastrea fairbanksi columnaris VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 373, pl. 96, figs. 1, 1a.

79. *Solenastrea fairbanksi minor* Vaughan

Solenastrea fairbanksi minor VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 373, pl. 97, figs. 2, 2a-2c.

80. *Solenastrea fairbanksi normalis* Vaughan

Solenastrea fairbanksi normalis VAUGHAN, U. S. Geol. Surv. Prof. Ppr. 98, 1917, p. 373, pl. 96, figs. 2, 2a-2c, pl. 97, figs. 1, 1a.

FISHES

81. *Carcharodon arnoldi* Jordan

Plate 23, figure 7

A well-preserved tooth of this shark was found at Loc. 3922 (U.S.G.S.) (No. 324542 U.S.N.M.). A cast of it is preserved as No. 1842 (C.A.S. Coll.). The identification was made by Harold Hannibal when the paper by Dr. Jordan and him was in preparation.⁷⁶

⁷⁶ See Bull. So. Calif. Acad. Sci., Vol. 22, pl. 2, July 1923, p. 55, for the record of the species in "Carrizo Creek."

Plate 20

- Figs. 1, 2. *Solenosteira anomala* (Reeve). Loc. 738 (U.C. Coll.); cast of plesiotype, No. 1808 (C.A.S. Coll.).
- Figs. 3, 4. *Cancellaria obesa* Sowerby. Loc. 738 (U.C. Coll.); casts of plesiotypes, Nos. 1797 and 1798 (C.A.S. Coll.).
- Figs. 5, 6. *Architectonica quadriceps* (Hinds). Loc. 738 (U.C. Coll.); cast of plesiotype, No. 1795 (C.A.S. Coll.).
- Fig. 7. *Strombus obliterated* Hanna, n. sp. Type No. 1809 (C.A.S. Coll.), from Loc. 682.
- Fig. 8. *Cassis subtuberosa* Hanna, n. sp. Paratype from Loc. 738 (U.C. Coll.); cast of same, No. 1800 (C.A.S. Coll.).
- Fig 9. *Bullaria striata* (Bruguière). Plesiotype, No. 1796 (C.A.S. Coll.), from Loc. 682.



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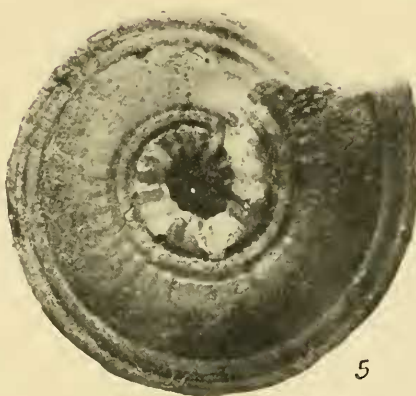
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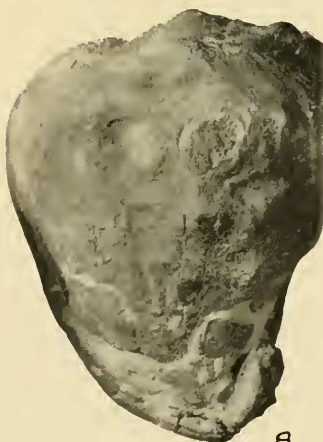
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Plate 21

- Figs. 1, 2, 3. *Turritella imperialis* Hanna, n. sp. Type and paratypes. Loc. 738 (U.C. Coll.); casts of same, Nos. 1811 and 1812 (C.A.S. Coll.).
- Figs. 4, 5. *Oliva spicata* (Bolten). Loc. 738 (U.C. Coll.); casts of plesiotypes, Nos. 1806 and 1807 (C.A.S. Coll.).
- Figs. 6, 7. *Conus fergusonii* Sowerby. Loc. 738 (U.C. Coll.); casts of plesiotypes, Nos. 1801, 1802 (C.A.S. Coll.).
- Fig. 8. *Conus regularis* Sowerby. Plesiotype, No. 1803 (C.A.S. Coll.), from Loc. 682.
- Fig. 9. *Ficus decussata* (Wood). Plesiotype, No. 1804 (C.A.S. Coll.), from Loc. 682.
- Fig. 10. *Malca ringens* Swainson. Plesiotype, No. 1805 (C.A.S. Coll.), from Loc. 682.

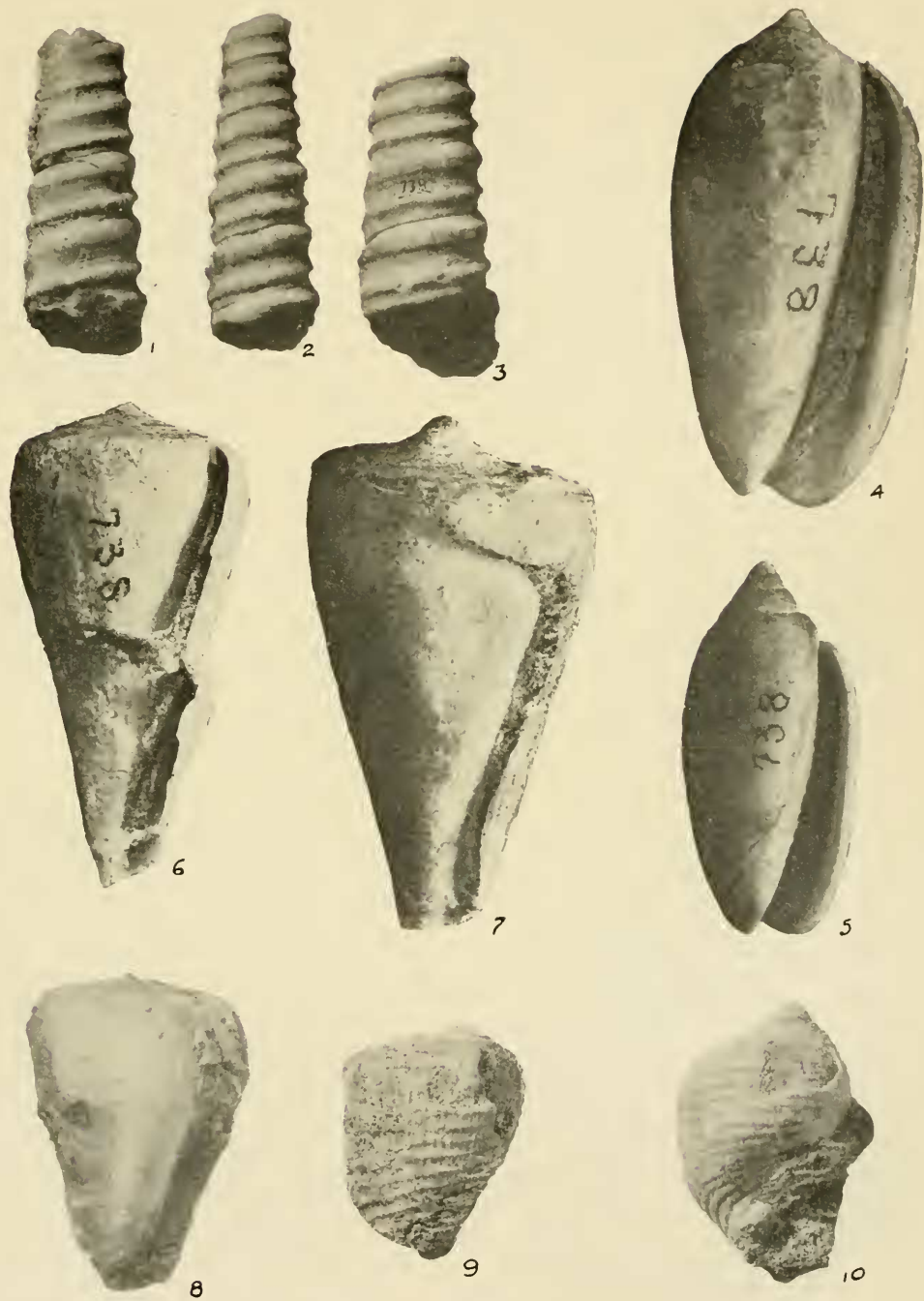


Plate 22

- Figs. 1, 2, 3. *Pecten sancti-ludovici* Anderson & Martin. Figs. 1, 3 from plesiotypes, Nos. 1834, 1835 (C.A.S. Coll.), from Loc. 681. Fig. 2 from plesiotype in U. C. Coll., from Loc. 55 (738).
- Figs. 4, 5. *Terebra gausapata* Brown & Pilsbry. Plesiotype from Loc. 738 (U.C. Coll.); cast of same, No. 1810 (C.A.S. Coll.).
- Fig. 6. *Pecten mediacostatus* Hanna, n. sp. Paratype, No. 1831 (C.A.S. Coll.), from Loc. 681.
- Figs. 7, 8. *Ostrea heermanni* Conrad. Plesiotype, No. 1825 (C.A.S. Coll.), from Loc. 693.

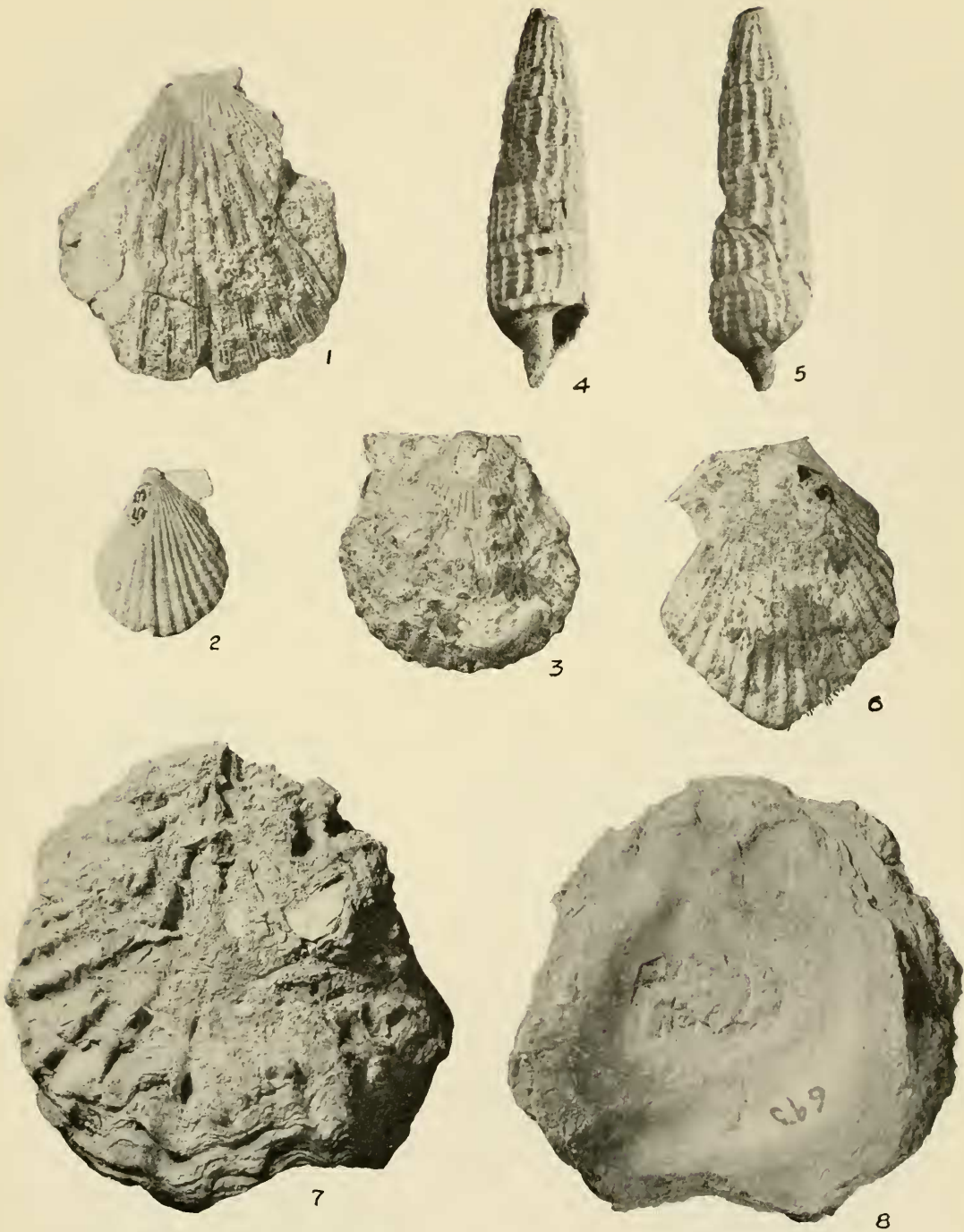


Plate 23

- Figs. 1, 2. *Ostrea heermanni* Conrad. Plesiotype, No. 1826 (C.A.S. Coll.), from Loc. 693.
- Figs. 3, 4, 5. *Anomia subcostata* Conrad. Plesiotypes, Nos. 1813, 1814, 1815 (C.A.S. Coll.), from Loc. 684.
- Fig. 6. *Metis excavata* Sowerby. Plesiotype from Loc. 738 (U.C. Coll.); cast of same, No. 1841 (C.A.S. Coll.).
- Fig. 7. *Carcharodon arnoldi* Jordan. Plesiotype, No. 324.542 (U.S.N.M. Coll.); cast of same, No. 1842 (C.A.S. Coll.).

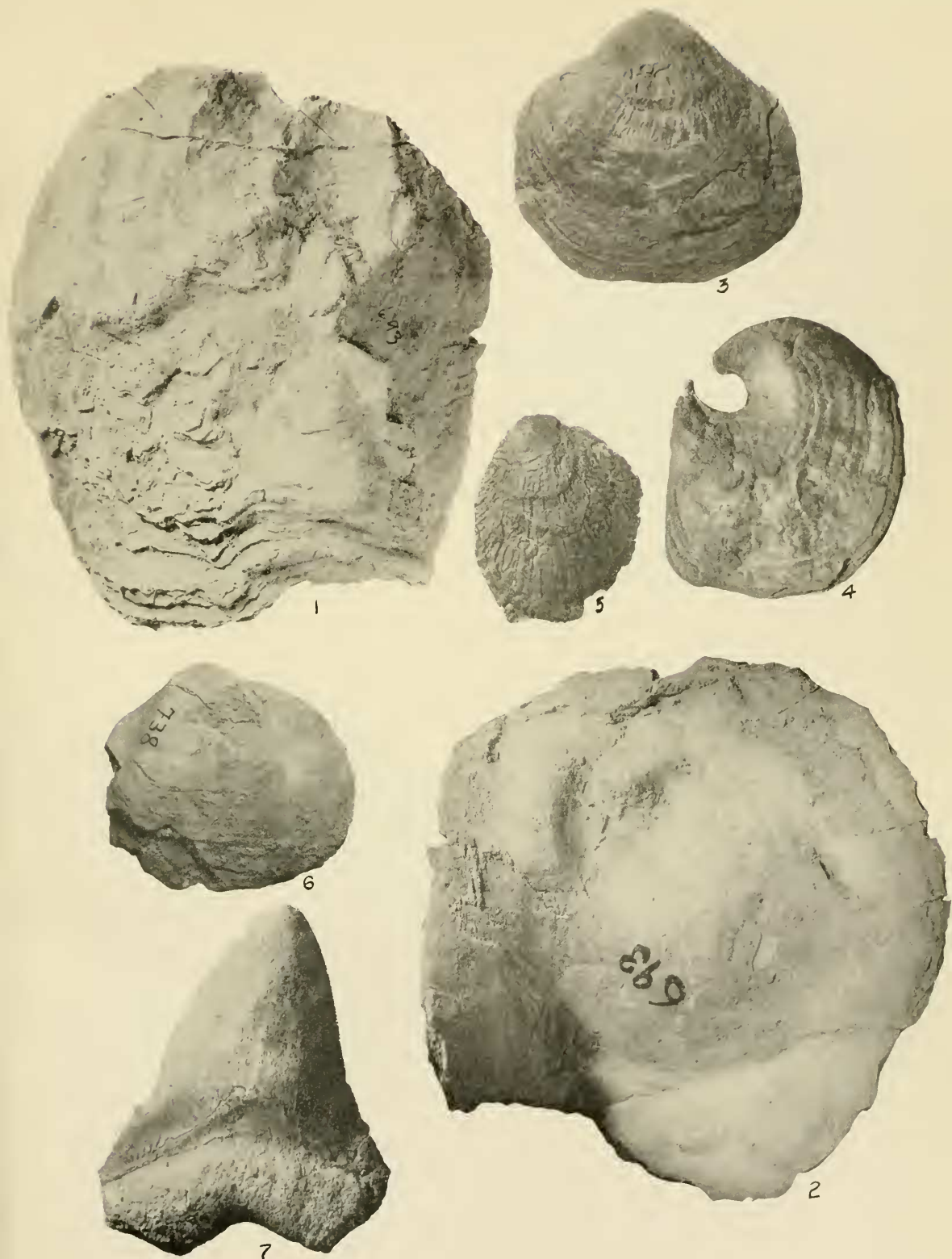


Plate 24

- Fig. 1. *Metalia spatagus?* (Linnæus). Plesiotype, No. 324.541 (U.S.N.M. Coll.); cast of same, No. 1822 (C.A.S. Coll.).
- Fig. 2. *Pecten mediacostatus* Hanna, n. sp. Type, No. 1830 (C.A.S. Coll.), from Loc. 681.
- Figs. 3, 4. *Spondylus bostrychites* Guppy. Plesiotype from Loc. 738 (U.C. Coll.); cast of same, No. 1840 (C.A.S. Coll.).



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Plate 25

- Figs. 1, 2, 3. *Pecten deserti* Conrad. Plesiotype from Loc. 738 (U.C. Coll.); cast of same, No. 1844 (C.A.S. Coll.).
- Figs. 4, 5. *Pecten mendenhalli* Arnold. Plesiotype from Loc. 2064 (U.C. Coll.); cast of same, No. 1833 (C.A.S. Coll.).
- Fig. 6. *Pecten subnodosus* Sowerby. Plesiotype from Loc. 738 (U.C. Coll.); cast of same, No. 1829 (C.A.S. Coll.).



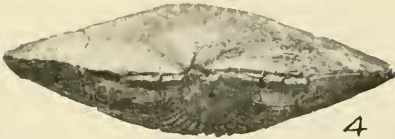
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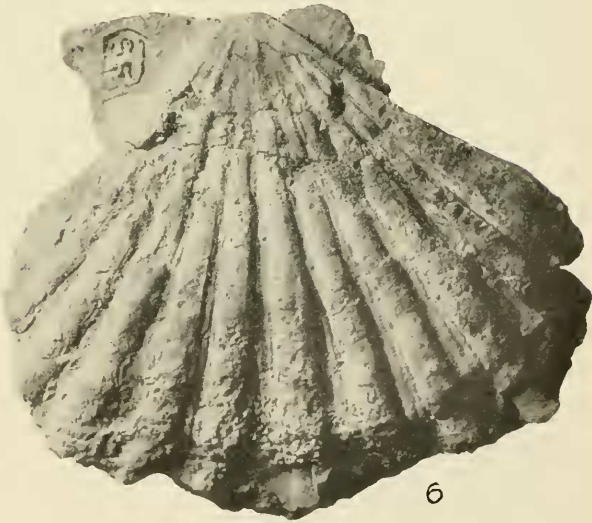
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Plate 26

Figs. 1, 2, 3. *Ostrea vespertina* Conrad. Plesiotype, from Loc. 738 (U.C. Coll.); cast of same, No. 1827 (C.A.S. Coll.).

Figs. 4, 5, 6, 7. *Ostrea iridesccens* Gray. Plesiotypes, Nos. 1823, 1824, from Loc. 692 (C.A.S. Coll.).

Figs. 8, 9. *Divaricella eburnea* (Reeve). Plesiotype, from Loc. 738 (U.C. Coll.); cast of same, No. 1820 (C.A.S. Coll.).

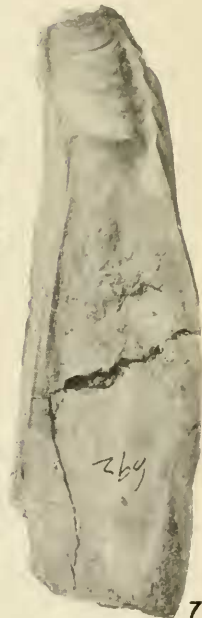
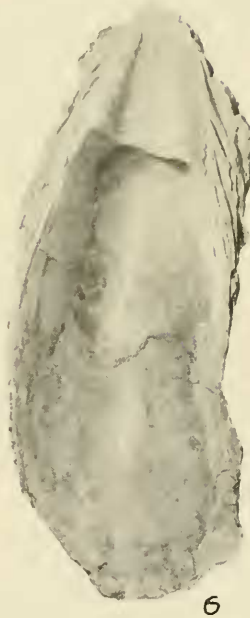


Plate 27

- Fig. 1. *Pinna latrania* Hanna, n. sp. Type, No. 324,593 (U. C. Nat. Mus. Coll.), from Loc. 3922 (U.S.G.S.); cast of same, No. 1827 (C.A.S. Coll.).
- Fig. 2. *Pinna mendenhalli* Hanna, n. sp. Type, No. 324,593 (U. S. Nat. Mus. Coll.), from Loc. 3922 (U.S.G.S.); cast of same, No. 1839 (C.A.S. Coll.).
- Figs. 3, 4. *Atrina stephensi* Hanna, n. sp. Type in San Diego Society of Natural History from Coyote Mountain, Imperial County, California; cast of same, No. 1816 (C.A.S. Coll.).

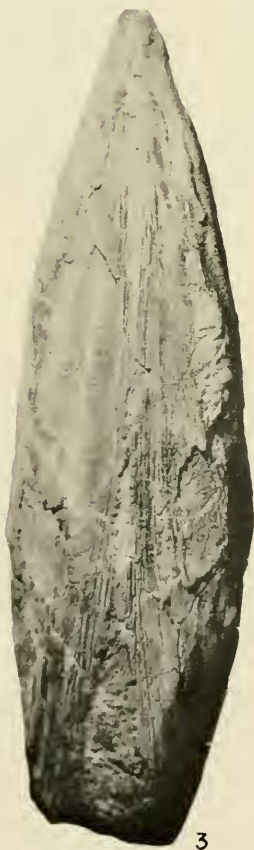


Plate 28

- Figs. 1, 2, 3, 4. *Crassatellites subgibbosus* Hanna, n. sp. Figs. 1, 2, from paratypes, from Loc. 738 (U.C. Coll.); casts of same, No. 1819 (C.A.S. Coll.); figs. 3, 4, from type, No. 1818 (C.A.S. Coll.), from Loc. 682.
- Figs. 5, 6. *Barnea costata* (Linnæus). Plesiotype, No. 324,575 (U. S. Nat. Mus. Coll.), from Loc. 6847 (U.S.G.S.); cast of same, No. 1817 (C.A.S. Coll.).
- Fig. 7. *Phacoides xantusi* Dall. Plesiotype, from Loc. 738 (U.C. Coll.); cast of same, No. 1836 (C.A.S. Coll.).



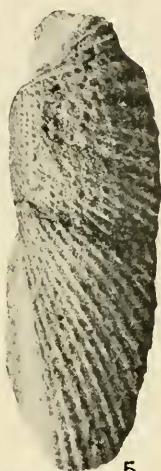
1



2



3



5



6



4



7

Plate 29

- Fig. 1. *Phacoides xantusi* Dall. Plesiotype from Loc. 738 (U.C. Coll.); cast of same, No. 1836 (C.A.S. Coll.).
- Figs. 1, 2. *Cassis subtuberosus* Hanna, n. sp. Type from Loc. 738 (U.C. Coll.); cast of same, No. 1799 C.A.S. Coll.).

